POWER

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ELY C. HUTCHINSON, *Editor*

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Education and Ability

I HAVE a pitiful, pessimistic letter from a discouraged man. He is in the thirties and has spent all of his life graduating. Such jobs as are open to him he could have got without an education and his fellow-workers twit him about the uselessness of his high-brow outfit.

He is like a mechanic with a chest of fine tools but without the skill to use them.

His creditable working of himself through college and his collection of a library count for nothing. His diploma does not get him a genteel job. The door of opportunity is closed to him. There is no more room at the top.

But it is a fact that high-class men are more in demand than mediocre men.

I do not mean by this that there are more positions of responsibility and high emolument than there are of run-of-mine jobs, but that it is harder to find competent generals than it is to recruit privates.

And when one of the higher positions is to be filled they do not ask a man how many diplomas he has or how many books he owns, but what he has done.

They are not interested even in what he knows so much as they are in the extent to which he has been successful in translating what he has learned into usefulness.

A college education, the possession of a library, the completion of a correspondence course, do not carry with them the assurance even of a job. They are acquisitions which, properly applied, will assist one to convert a job into a position and a position into a career.

A man who has not been spoiled by the atmosphere of the campus and the possession of a diploma can apply the knowledge that he has acquired to the seemingly sordid operations of running a boiler room and make a sport of it. There is as much satisfaction in a good CO_2 record as there is in a good golf score. There is achievement in troubles met and mastered and credit in improved efficiency.

There is room at the top, but the air routes to it are few and exclusive. The most and best of those who have got there did it by climbing.

And no small proportion of them started at the lower rung.

The one who will rise the fastest is the one who can demonstrate his greatest usefulness. An education will help him to do this, but it must be intelligently employed and not kept rolled up in a diploma.

F. R. Low

EDITORIALS

Power and the Public

WHY SO MUCH talk about power projects and power politics wherever men and women gather? Why so much power news and editorial discussion in the daily press? "Romance" is one answer. The power field—to the outsider, at least—is distinctly romantic. The average citizen gets a "kick" when he reads in his paper about "giant turbines revolving at enormous speeds," and "huge boilers operated at terrific pressures."

But there is more than romance. The subject of power generation, distribution and application is of intense practical significance to everybody. Not only that—the average man has something to say about it through the political pressure he can bring to bear on legislative bodies and utility commissions.

When, for practical reasons, utilities are granted complete monopolies, it is universally admitted that the state acquires the right of regulating them in the public interest. This brings the average voter into the picture, and—in our system of government—he belongs there.

But, as in all types of democratic control, effectiveness depends largely on the intelligence and clear vision of the electorate. Inevitably the average understanding or misunderstanding of power problems will be reflected in the attitude of public officials. It follows that organization of the utilities to protect their own interests is equally inevitable.

These two influences, both unavoidable under our system of government, carry with them their dangers. In the case of the voters, the danger is misinformation—an incomplete understanding of power problems as they affect the individual and community. The utilities, on the other hand, may now and then be tempted to step over the lines of legitimate self-protection.

In the matter of informing the public on power problems, the utilities themselves have done much. They have been able to show tremendous benefits to the public from a growing and less costly supply of power. Unfortunately, information from this source, and particularly through some of the channels used, carries a handicap. Even the most honest of statements may be suspected.

There is, therefore, a growing need for independent engineers and economists able and willing to discuss these problems purely from the angle of public interest without political or industrial bias. As such writers and speakers appear they will gain the confidence of the public and do much to keep both the public and utilities on the straight and narrow path of good business and good government.

Synchronous Motors for Plant Auxiliary Drives

DESIGNING engineers have been reluctant to use synchronous motors for power station auxiliary drives. In the past there was some justification for this attitude. The motor's starting characteristics were not the best, and if something happened on the system to throw the motors out of step, they would stall.

The objections to the older types of synchronous motors have been overcome in modern designs, and they are being used in some of the most complex industrial applications. Motors up to nine thousand horsepower capacity are used for drives in steel mills, and a large motor is being installed on a reversing drive for a brass mill. It will be started, stopped and reversed every few seconds, which necessitates satisfactory starting characteristics.

A two hundred and fifty horsepower motor driving a hammer mill will develop one hundred and fifty per cent starting torque and one hundred and fifteen per cent pull-in torque. It is guaranteed to carry six hundred horsepower load at rated voltage, without pulling out of step, to carry full load as an induction motor for five minutes, and to synchronize if the load falls below two hundred and ninety horsepower. When pulled out of step, it will operate as an induction motor and pull back into step when conditions become normal. Such operation is all that is required of any auxiliary drive.

Control for synchronous motors has been developed to where it is simple, automatic and reliable; the motors

can be started by a push-button or any other remote-control means. Their speed cannot be controlled as can the slip-ring type, but several two-speed synchronous motors are in successful operation.

One advantage of synchronous motors is that their power factor can be controlled, which makes them desirable drives on alternating-current systems. The power companies are encouraging the use of synchronous motors on industrial loads to improve power factor. This practice is economically sound and might well be extended to the plants where the power is produced. One of the largest single loads on most steam central stations is for plant auxiliary drives. This load usually has the lowest power factor of any on the system.

The Danger of Ill-Considered Statements

ACCORDING to a recent news report, the president of a large railroad predicted that because of the improved efficiency of steam plants present hydro-electric projects would in twenty years be abandoned. Apparently this industrial leader has forgotten the safety-first law of the railroads, to "Stop, Look and Listen" at all crossings. Since the speaker represents a railroad with a large traffic in coal, perhaps a wish for more business was father to the thought. But one who has won high standing as an industrial leader should know that economic law and not legerdemain controls industrial changes. Without a knowledge of fundamentals it is dangerous to prophesy.

Taking the statement as it stands, it is foreseen that twenty years hence steam plants must be built to produce a kilowatt-hour for a fraction of a mill, to better the operating charge in a hydro plant. What the thermal efficiency of steam plants will be in twenty years cannot be foretold. It is certain, however, that the law of diminishing returns is already having influence on their economy. This raises grave doubt of radical reduction in power cost. Assuming the present low figure of one pound per kilowatt-hour, and five-dollar coal, fuel cost is two and one-half mills per kilowatt-hour.

Considering fuel alone, if the railroad president's prediction is to materialize, there must be a radical reduction both in fuel consumption and cost to produce a kilowatt-hour by steam for a fraction of one mill. This condition is not favorable to coal mine operators nor to railroads that haul the fuel. If the speaker were familiar with the simple fundamentals he doubtless would have realized these facts and would have seen that present conditions in steam plants are more favorable to the coal business than those he predicts.

It is regrettable when men of high standing in industry make ill-considered statements upon subjects of such great public interest as power development. For many years water power was held before the public by politicians and others as something that would put cheap power within reach of everyone. This prophesy has failed of fulfillment, and now that steam power has been developed to compete economically with many water-power developments there is a tendency to consider hydro-power a false hope and to look to steam plants to usher in the millenium. Both doctrines are wrong and misleading. Steam- and water-power plants each have a place in the expansion of the nation's power system.

Economic changes may temporarily throw the balance in favor of one or the other, but water powers will be developed as long as sites are available for such projects. Notwithstanding all that has been said of water power no longer being able to compete economically with steam, hydro-electric development is now showing great activity in a large coal-mining region. Power prophets may well ponder the economics of this.

Publicity for the Plant Engineer

THE PLANT ENGINEER, like the actor and politician, needs publicity. Of course, it is not the kind of publicity required by these professions, which shout their achievements to the general public. This would be of little value to the plant engineer, but he is interested in keeping the factory management informed regarding his achievements in the power plant. He wants them to know that power and steam are generated economically, that these services are being conserved, and that the plant is well maintained.

The best agency that the plant engineer has for securing this publicity is the records he maintains. The daily log that he keeps in his own files should contain a record of plant operation in great detail, but the weekly, monthly and yearly reports should be simple, and in language easily understood by the management. It is from the information in these reports, and the accuracy and manner in which they are presented, that the management judges the efficiency of the engineer. It matters little how well the plant engineer may know his own efficiency—for to be of material value to him it must be known by others.

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POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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Otis Elevator Company

RECONDITIONS *Its* YONKERS POWER PLANT

After reconditioning its power plant the Otis Elevator Company finds it more economical to generate as much power as possible and to purchase only the power necessary to carry the peaks.

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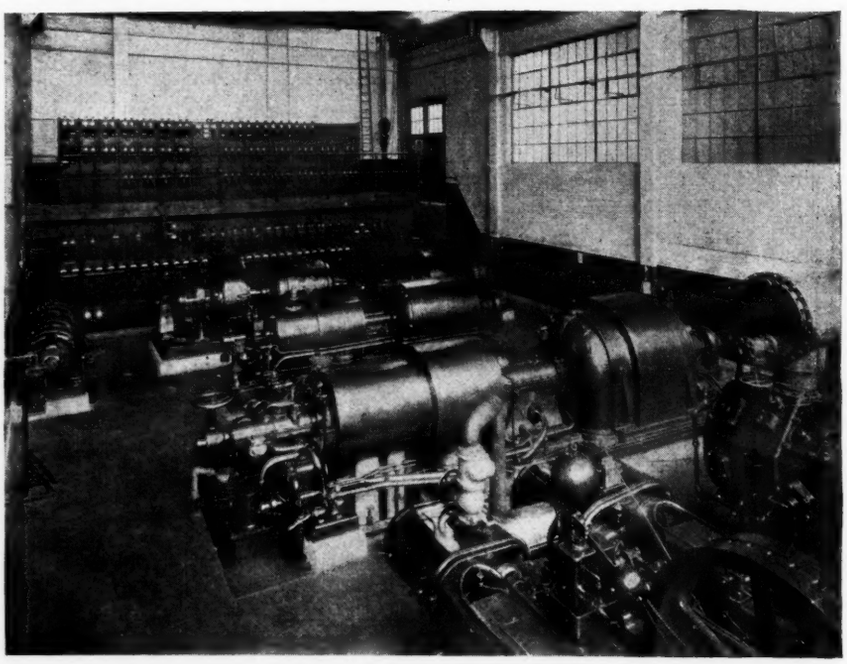
EARLY in 1928 it became evident to the engineers of the Otis Elevator Company that the steam and power demands of their expanding Yonkers plant would soon outgrow the capacity of the power house. As most of the equipment then in operation had seen more than twenty years of active service and was, therefore, not very efficient as measured by present-day standards, it was decided to recondition the plant. The ten old boilers were replaced by three new ones and two back-pressure turbine units replaced the old corliss engines. In making these changes it was, of course, necessary to plan construction work so that steam and power were always available for manufacturing uses.

The power house must supply steam at 100-lb. pressure for various plating and Parkerizing processes, and low-pressure steam during the winter for building heating. The pressure for which the new boilers were designed was selected so that the steam required for heating would produce the power requirements of the plant in passing through the back-pressure turbine units. Since during the summer there is no use for low-pressure steam the exhaust from the turbine is lost to the atmosphere.

To minimize the amount of exhaust to the atmosphere and the amount of "expensive kilowatts" generated it was at first thought that some economy might result if a portion of the power required by the plant were purchased from the local utility. Of course, all of the power could be purchased during the summer, which would prevent the loss of any exhaust steam. However, it has been found this procedure will not result in lowest total power and steam costs.

During the summer is is necessary to operate the boilers, even though no power is generated, to furnish steam at 100-lb. pressure for plant use. Such operation requires practically the same labor charges in the boiler room as though power were generated. The same is true of the engine room, where air compressors, motor generators, and switchboard require operators on duty whether or not power is generated.

Thus the only additional costs that can be charged to generation of power during the summer months is the cost of fuel and a slight increase in power plant auxiliary use. With a turbine steam rate of about 27 lb. per kilowatt-hour and an evaporation of 10 lb. of water per pound of coal, a kilowatt can be generated for about 2.7 lb. of coal, or with coal at $5 per ton an additional kilowatt costs only about 7 mills. As this is less than



New turbine room, showing air compressors in the foreground and switch board at the rear

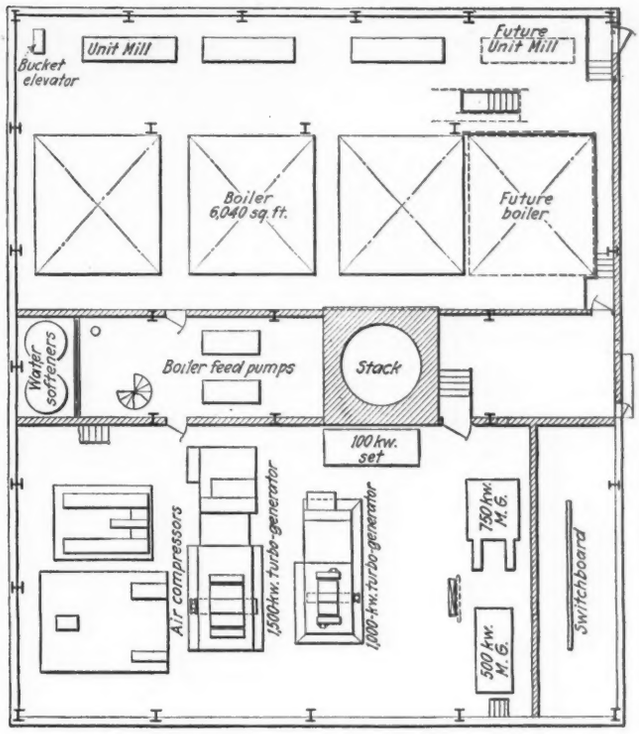
the cost of purchased power, it was decided to generate all of the power possible with the present equipment. This amounts to about 627,000 kw.-hr. a month. The present plant has not quite enough generating capacity to supply all of the factory power requirements, and about 70,000 kw.-hr. additional energy must be purchased per month.

The rebuilt plant contains three water-tube cross-drum boilers each containing 6,040 sq.ft. of heating surface and designed to operate at 260-lb. pressure. Coal is received by boat and trucked from the Hudson River to the plant, where it is dumped into a concrete hopper large enough to hold a little more than one truck load. A bucket elevator carries the coal to the top of the plant and delivers it to a coal crusher of 40 tons' per hour capacity. A screw conveyor distributes the crushed coal to a 200-ton cast-iron bunker, from which it falls by gravity to unit pulverizers.

For normal operation one 6,000-lb.-per-hour unit mill per boiler was installed on the boiler room operating floor. To provide pulverized coal during periods of very low loads a smaller mill of one ton capacity was installed in the boiler room basement. This mill is arranged so that it can supply coal to any of the three boilers. The amount of coal consumed by each boiler is checked by meters placed in the pipe between the bunker and the mills.

Pulverized coal is delivered to the combustion space of each boiler through two turbulent-type burners. The furnace is 13 ft. 6 in. x 15 ft. 6 in. x 20 ft. high, and has a volume of about 4,200 cu.ft. It is air-cooled on four sides and bottom. Cooling air is drawn in through four openings in the front, two on either side of the burners, and through three openings in each of the side walls. After passing through the walls and furnace bottom the air, at a temperature of about 180 deg., is used for primary air in the mills.

Furnace bottoms are provided with access doors, so that the ash collecting there may be hoed out into a trough in the front and the rear of the boilers. A steam conveyor system removes the ash from the trough and delivers it to an elevated storage bin, from which it is removed by trucks. It is necessary to hoe out the ashes only once a day.



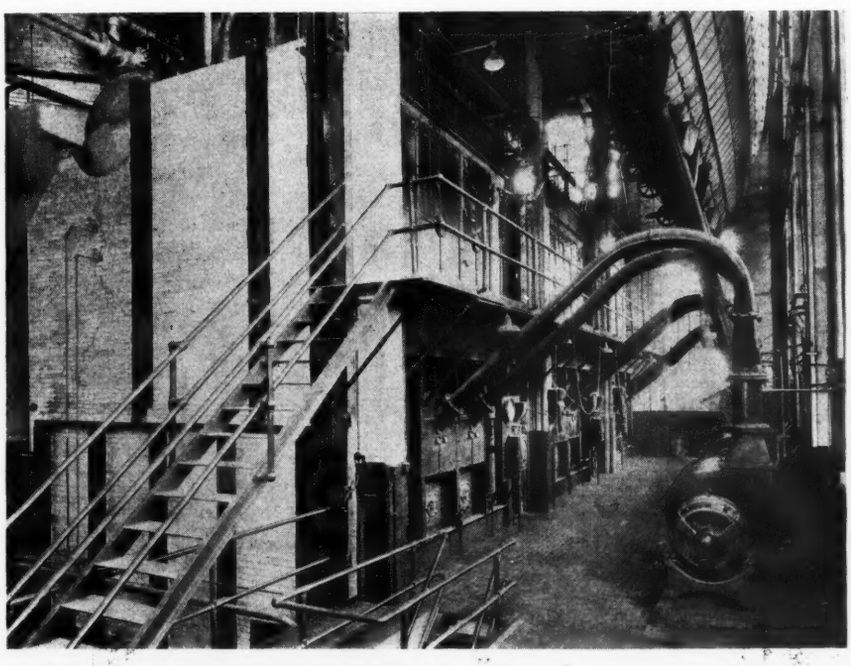
Plan of Yonkers power house of the Otis Elevator Company

TWO CO_2 recorders for the three boilers, multiple-pointer draft gages, and automatic combustion control aid in maintaining efficient plant operation. Venturi meters measure the boiler feed water and heating system returns, and the steam to the turbines is recorded by a flow meter.

Since during the summer all of the steam used by the turbines is lost to atmosphere, a large amount of make-up water is required. Zeolite softeners capable of treating 21,600 gal. per 4-hr. period have been installed to soften the raw water. From the softeners, which are located on the basement floor, the make-up water is pumped to an open heater, and returns from building heating and from traps are delivered to filters by automatic tank and pump. From the filters the water falls by gravity through the open heater to the suction of the boiler-feed pumps. Feed water is heated by a portion of the atmospheric exhaust to 210 deg.

Two feed pumps, one turbine-driven 250-g.p.m. centrifugal, and one 12 x 7 x 12 reciprocating pump, deliver feed water through water level regulators to the boilers.

Steam at 250-lb. pressure and 158-deg. superheat is used in the engine room to drive two back-pressure turbines, one of 1,000-kw. and one 1,500-kw. capacity, and also a two-stage air compressor. In addition



Three new pulverized fuel fired boilers installed in reconditioned boiler house

there are a synchronous motor driven air compressor, 500-kw. and 750-kw. motor-generator sets, and a 100-kw. multiple-voltage set capable of delivering current at 125, 250 and 500 volts for testing purposes.

The generators are provided with fin-type air coolers. Circulating water for the coolers is taken from the city water main, and after passing through the generator air coolers is used in the air compressors, aftercooler, and oil coolers. It is then collected in a tank, from which a 10-hp. motor-driven pump delivers it to the boiler house make-up water system. Surplus is distributed in the factory for plating processes, for wetting sand in the foundry, for lavatories, etc. A storage tank on top of a higher building is connected to this system and supplies water whenever there is a deficiency and in case of trouble with the pump. Water to this tank is supplied by the city mains under float control. This system has brought about a large reduction in the water bill.

During a normal day the boilers generate about 1,000,000 lb. of steam. Of this, 866,000 lb. is used in the turbines, 56,000 lb. in the engine-driven air compressor and 90,000 lb. goes to process. On a mild winter day about 377,000 lb. of exhaust steam is used for heating. Under these operating conditions purchased and generated power together cost less than 2 cents a kilowatt.

In the old plant the axis of the boiler house ran the long way of the building, perpendicular to the present line of boilers. The new plant was built around the old 8-ft.-diameter 175-ft.-high stack. To do this four of the old boilers were removed, giving space for the new boilers. A temporary steam main was then run to the old engines, allowing them to be operated on steam from the new boilers. The remaining old boilers were then dismantled, permitting the new turbine and motor-generator sets to be installed.

This article was obtained through the courtesy of D. F. Taber, superintendent of maintenance of the Yonkers plant.

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Mile-Long Dam Features Ghost Hydro Development

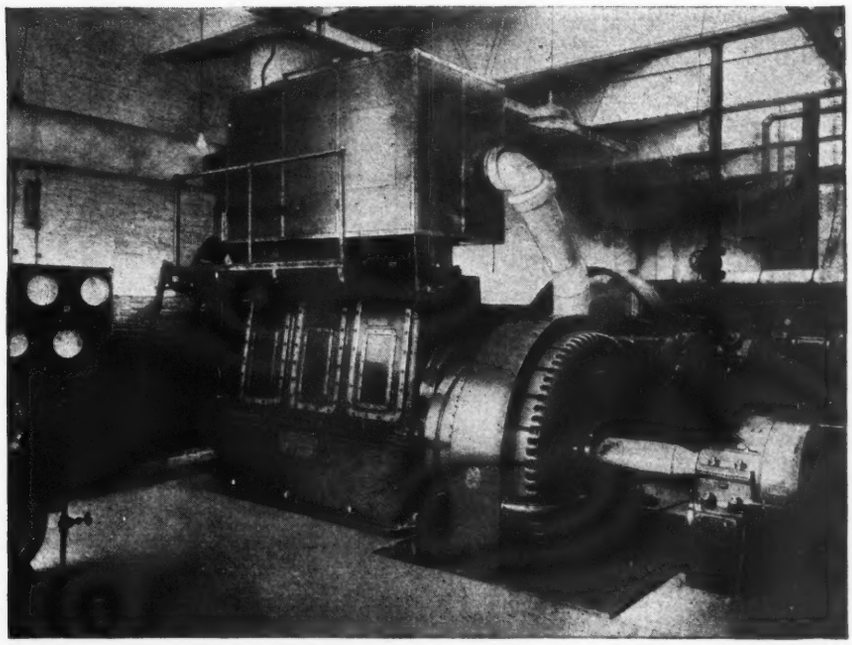
TOWARD the end of 1929 the Calgary Power Company completed and brought into operation its 36,000 hp. development at the Ghost site on the Bow River about thirty miles west of Calgary, Alberta.

This undertaking involved the construction of works spanning the Bow River immediately below the entrance of Ghost River, the structure having a total length of almost a mile and providing a head of 105 feet and a pondage of 45,000 acre-feet. The power station, designed to contain three 18,000 hp. units, two of which are being initially installed, is of concrete construction and is integral with a concrete gravity dam. Flanking the concrete dam to the south is an earth (hydraulic) fill dam with a maximum height of about 65 feet, which extends about 2,000 feet across bench lands to the higher grounds, where the main sluiceway dam is located, to provide for the discharge of surplus water. To the north the concrete dam connects with Ghost Hill.

The Ghost plant, together with the existing upper plants on the Bow River at Kananaskis and Horseshoe near Seebe, Alberta, will give a total hydro-electric development of 68,000 hp. on the Bow River, and will be operated in conjunction with the two upper plants, so that full use may be made of the total available flow and also the existing storage at Lake Minnewanka. The storage at Minnewanka is some 44,000 acre-feet, which is used to augment Bow River flow during winter. At the present Seebe plants it has a value of some 4,800,000 kw.hr. of output, and when this same storage is used again at the Ghost plant it will have a total value of 8,530,000 kw.hr.

One of the most interesting problems in connection with the undertaking was the location of the power house. The site of the gravity dam itself was chosen so that its base might rest on the hard sandstone bands, and the power house, which is incorporated in the dam structure, was placed so that a large portion of the excavation for wheel pits and draft tubes might come in the softer intermediate shales and have its base and back walls rest on the lower thick layer of sandstone.

The power station is built integral with the dam and has an installed capacity of 36,000 horsepower



A three-cylinder Skinner constant-lead engine on test

Details of The Skinner Vertical Unaflow

FOR MANY applications vertical steam engines are superior to horizontal units, but until recently no valve gear that would give constant lead was available, and to obtain proper balancing of a uniflow engine constant lead is desirable.

The Skinner Engine Company has developed an improved valve gear that with flat-faced cams gives constant lead, with a variable cut-off; and that can operate at comparatively high speeds. This has permitted the company to bring out a multi-cylinder design of uniflow engine, in capacities from 200 to 1,250 kilowatts, with cylinders of the proper dimensions.

The engine is of the three-cylinder type, cylinders being cast separately, and it is equipped with the expansion-compensating, double-seat poppet admission valves that are used on horizontal Skinner engines.

Auxiliary exhaust valves are of the single-beat poppet type, located away from the ends of the cylinder, as in the horizontal construction, and are built to disengage automatically from their cams and remain closed for condensing operation, and to come into operation if the vacuum is lost.

It was desired to overcome packing and alignment troubles that sometimes develop when the guides are attached to the side of the frame, due to the difference in expansion between the cylinders and the frame.

As shown in Fig. 3, each guide is of the bored type and is integral with the spacer piece, which is mounted on top of the frame and supports the cylinder. This insures that the guide at all times is concentric and parallel with the cylinder bore, regardless of temperature changes. If for any reason the parts were dismantled, it would be impossible to reassemble them so that they would be out of line with each other.

Instead of the usual full-bored guide construction of the horizontal engine design, flat retaining guides are bolted to the sides of the main guide to support the crosshead, making the crosshead boxes extremely accessible.

Crosshead and pins are made from a single-piece forging, into which the piston rod is inserted and locked by a specially designed lock nut. A marine design is used in the connecting rod construction, with the rod drilled throughout its entire length for carrying forced-feed oil to crosshead bearings, guide and shoe.

Four main bearings are provided for the three-throw crankshaft, each crank, therefore, having a bearing on each side. The bearings can easily be removed by relieving the weight of the shaft from the lower half.

To operate the valve two camshafts, Fig. 2, are employed, on one of which are mounted cams *A* for opening the admission valves and cams *C* which operate the auxiliary exhaust valves. The second camshaft carries the cams *B* for closing the steam valves.

A worm gear on the cut-off camshaft is driven from a vertical-drive shaft by a worm which is splined on the vertical shaft and moved up or down by the action of the vertical centrifugal governor; thereby altering the

timing of the cams *B* relative to the crankshaft. The miter spiral gear on the lead camshaft meshes with a similar gear keyed to the vertical driving shaft, so that the lead camshaft *A* is fixed in respect to its cam positions relative to the crankshaft.

The valve action can be seen from Fig. 1. It should be understood that the steam valve will not open as long as either the lead or cut-off cam has its "low" surface in contact with its roller. In other words, the two cams must have their "high" surfaces against the valve rollers to cause the valve to be held open. As shown at the left of Fig. 1, the cut-off cam *B* has its high point under the roller of the top steam valve and the lead cam *A* has just raised the roller, or admission has just occurred.

At the same time the low points of the two cams are in contact with the rollers of the lower valve, so this valve will remain closed. Continued rotations of the two cams bring the valve to the cut-off position, shown at the right of Fig. 2. Here *A* has its high side under the roller of the upper valve, and the valve cut-off cam *B* is leaving its roller, so that cut-off is occurring.

Continued rotation of the camshafts causes lead of the lower valve and later cut-off of the upper valve. The admission and closing cams have the same contour.

Cams and rollers being flat-faced, contact between them is a line contact and, by reason of the construction of the gear, the pressure between the roller and its cam is only one-half that required to lift the valve. This, together with the simple tangential form of cam, gives long life and produces no excessive thrust on the tappet, guide, governor or camshaft bearings.

All other bearings, including the crosshead and guides, are lubricated by oil with a pressure of approximately 25 lb. Oil from the valve gear returns through the governor housing to the crankcase, amply lubricating all the governor parts and all vertical shaft bearings.

By loosening six thumb-screws, three sections of the cylinder lagging are removed, allowing inspection and adjustment of the valve tappets without removing or changing the adjustment of any of the valve gear parts.

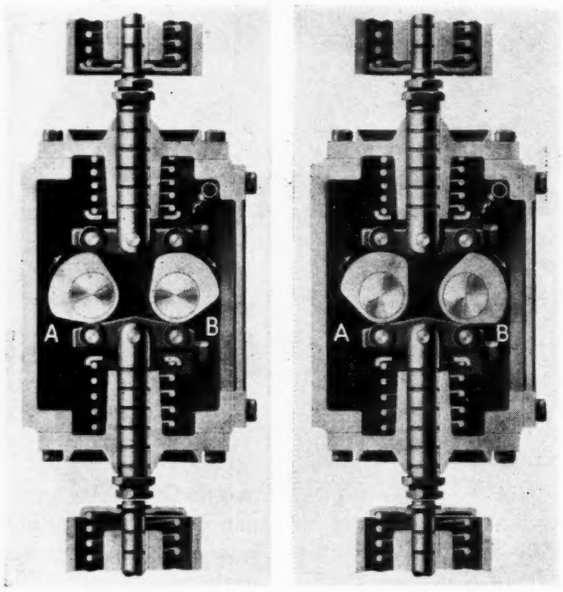


Fig. 1—Action of the lead and cut-off cams

It will be noted that there is plenty of room in the spacer head for adjustment or removal of the metallic packing. For easy removal, packing may be dropped down on the crosshead, where it is accessible through the large doors in the main frame.

A positive-displacement rotary pump, designed to prevent churning of the oil, is coupled to the lower end of the vertical governor shaft and operates at the same speed as the engine.

Oil under a pressure of approximately 25 lb. is forced to the main bearings through pipes. From there it is conducted through drilled holes to the crankpins, crosshead pins, crosshead shoes and guides.

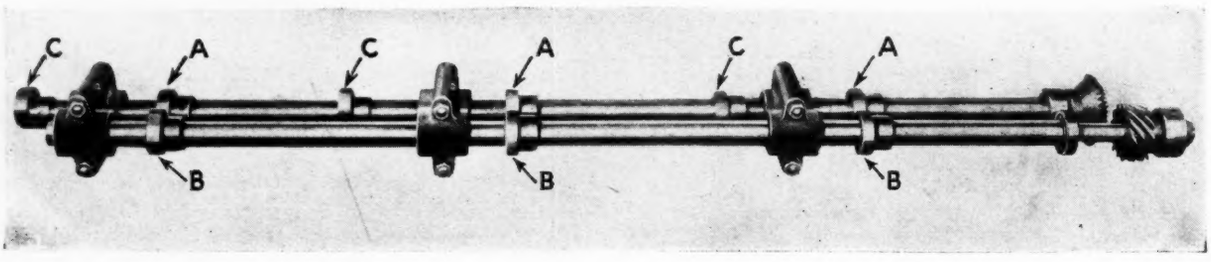
An auxiliary oil line is carried to the valve-cam box, delivering oil under pressure to each of the camshaft bearings, and a jet of oil is directed upon each pair of cams and rollers, as well as upon each set of gears. Oil from the jets returns through the governor housing to the crankcase, thereby lubricating all of the governor parts and bearings on the vertical shaft. After being used, oil is drained to a filter tank holding 50 gal., where any water, as well as foreign matter, is filtered out. The tank is equipped with water-cooling coils for reducing the temperature of the oil before it is again pumped through the system. This reservoir, as well as the crank pits in the engine, is accessible for easy cleaning.

Oil gages are neatly mounted on the end of the frame, together with an automatic signal for notifying the operator in case of oil-pressure failure.

Cylinder lubrication is accomplished by an adjustable forced-feed pump having six feeds that force oil into each of the steam valve boxes, where it is atomized before being carried into the cylinders by the flow of steam.

Up to the present time, 68 shop economy tests have been conducted, several of them by engineers employed by engine purchasers. One purchaser, who keeps extremely accurate daily records, reported that for eight consecutive days his engine showed an average steam rate of 27.8 lb. per kilowatt-hour. This included the steam for the boiler-feed pump and the stoker engine. Average steam conditions were 175-lb. pressure, 100-deg. super-

Fig. 2 — The two camshafts used on the engine



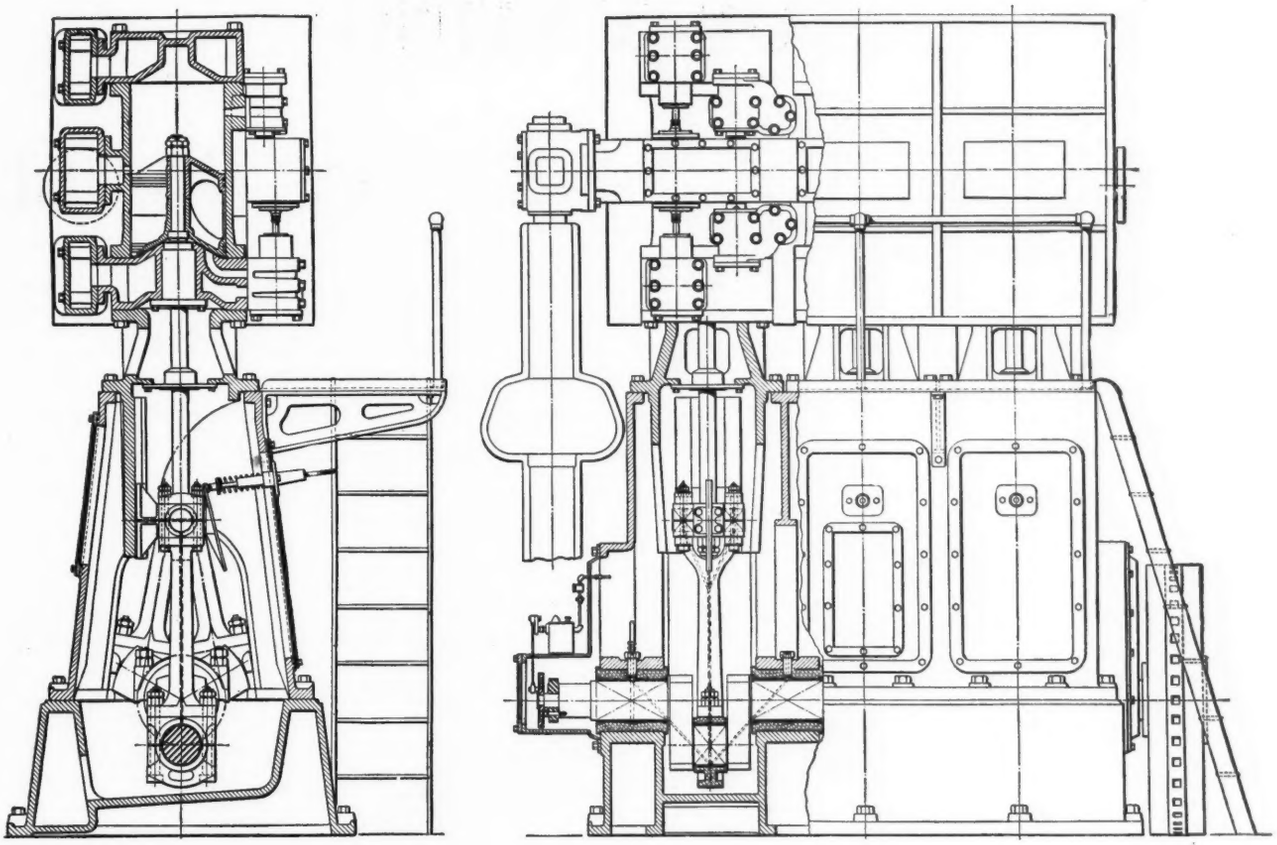


Fig. 3—Section of the engine, showing the crosshead guide construction

heat and 2-lb. back pressure. Inasmuch as the boiler equipment was showing an average evaporation of 9.55, the coal rate per kilowatt-hour, including boiler-feed pump, stoker engine and power-plant losses, was 2.91 pounds.

This type of engine has a special field of application in office buildings where floor space is limited but ample head room is available. Due to the balancing possible with three-cylinder engines, vibration—a thing that is often troublesome with a single-cylinder engine unless a foundation vault is used as a damper device—is absent.

For industrial works the vertical engine permits a large horsepower capacity to be placed in a relatively small floor space. The pressure feed and other safety devices enable the engine to operate continuously with a minimum of attention.

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Pennsylvania Leads in Coal Production

PENNSYLVANIA in 1929 regained its position as the state having the largest production of bituminous coal. According to Bureau of Mines estimates for the past year, that state had a total output of 142,400,000 tons, as against 138,015,000 tons for West Virginia. The Pennsylvania figures include an allowance for additional tonnage loaded on the Monongahela River, which was reported to the bureau late in the year and is slightly higher than the original weekly estimates indicated.

The showing is significant when compared with the totals for 1923, the last year before the great depression in coal set in. In 1923 Pennsylvania produced 171,800,000 tons. The West Virginia production was 107,900,000 tons. Six years of shifting fortunes brought a decline of 17 per cent in Pennsylvania and an increase of 28 per cent in West Virginia. Ten years ago West Virginia was content to point to a modest advantage over Illinois. Today it challenges the leadership of Pennsylvania, and in 1927 and in 1928 actually passed it.

Of course, if anthracite is counted Pennsylvania's tonnage holds first place, being more than West Virginia's and Kentucky's combined.

The production of the several states in 1929 in per cent of the 1923 record of the states is: Illinois, 76 per cent; Indiana, 69 per cent; Ohio, 59 per cent; Michigan, 66 per cent; West Virginia, 128 per cent; East Kentucky, 139 per cent; Virginia, 111 per cent; West Kentucky, 128 per cent; Alabama, 87 per cent; and Tennessee, 95 per cent.

All of the northern states show a much smaller output than in 1923, and all of the Middle Appalachian states and western Kentucky show a substantial increase. The greatest increase comes in eastern Kentucky, which is 39 per cent. The Southern Appalachian states are slightly behind the 1923 level. This is due, to a considerable extent, to competition with fuel oil and hydro power.

OPERATING the BOILER

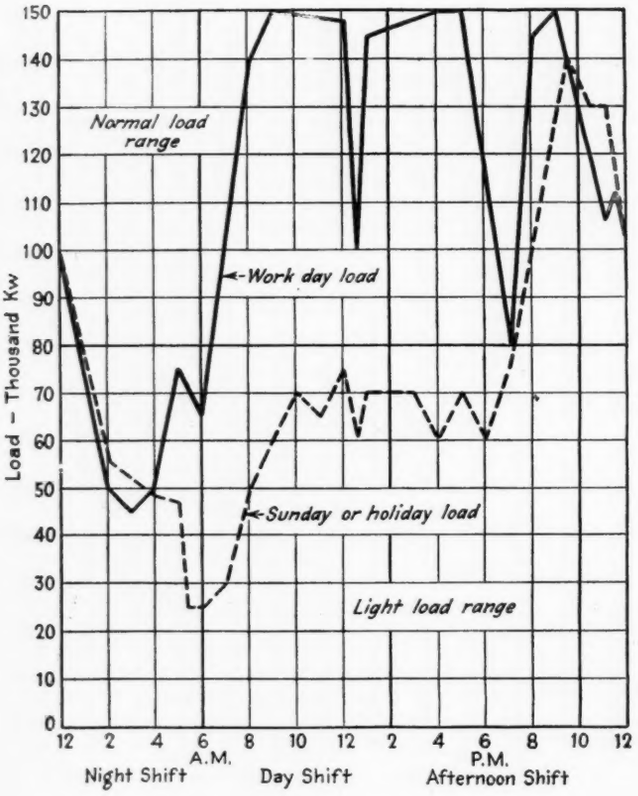


Fig. 1—The load demands to be met by the boiler house

Boilers in central stations can and should be operated on a time table or schedule. However, the procedure is quite different from the scheduling of a railroad, where after a study of traveler habits officials schedule the trains to leave at a stated time, and if travel is a little heavier than usual passengers are crowded in regardless

THE BOILER-ROOM engineer seldom knows ahead of time the amount of steam that he must send into the turbine room. But, by setting up a proper schedule of boiler operation, he can supply the steam needed without a marked pressure drop.

Steady steam pressure is needed in central stations to bring about the best economy, constant superheat, feedwater regulation, safety, proper loading of turbine-generators, control of frequency, availability of reserve turbine-generator capacity and comfortable operation.

Since each station load calls for a virtually definite amount of steam, it may seem an easy matter to vary steam output to hold the steam pressure steady under any condition, yet steam regulation is a problem without proper scheduling.

In Fig. 1 are typical load curves covering a work day and a holiday output of one central station. The portions of the curves between 80,000 and 150,000 kw. are in the normal load range. Portions above are in the overload range. Those below are in the light load range. Changing loads vary through the three ranges. When the load is above 80,000 kw. most of the boilers are in the steaming region, and when below some are banked. These are the usual operating conditions for a 180,000-kw. central station of the type shown in Fig. 2, with six 30,000-kw. turbine generators and twenty boilers in service. The other four boilers are out of service for maintenance or cleaning.

Six days a week the firemen are accustomed to take their boilers off the bank quickly and bring them to full steaming service to keep up with the increasing load. When a holiday or Sunday arrives the firemen tend to put boilers in service as on work days, and for a boiler room of the multi-aisled type, shown in Fig. 2, the result is that three boilers go in service, one from each aisle at least, when one boiler alone would be sufficient. With a decrease of holiday load it may happen that three boilers are banked when one should be banked.

The questions that a fireman has to ask himself at each change of boiler rating are:

When should the steam rating be changed?

How should the steam rating be changed?

How much rating is to be changed?

A boiler is very responsive in the steaming region to load changes, but when a boiler is swinging into the light-load region and three types of fires are to be handled the firemen needs instant information to answer the questions. The schedule, Fig. 3, anticipates his need for any load. All he has to do is to follow the schedule, which will take care of loads from 20,000 to 150,000 kw.-hr., in short, any that the station will probably have over the holiday.

The schedule shown was figured for a holiday load. Columns *a*, *b*, and *c*, respectively, give the numbers of the boilers being ordered in or out of service from aisles *A*, *B* and *C*. Column *d* gives the totalizing kilowatt meter reading, the station load at that instant. The number of steaming boilers in service and the total rating are given in columns *e* and *f*, while columns *g* and *h* show the number of "running-bank" boilers in service and the

ROOM on a TIME TABLE

By LEE G. BIRD
Mechanical Engineer, Chicago.

total rating. Column *i* shows the number of "dead-bank" boilers, column *j* the number of boilers burned off the header and out of service, and column *k* the turbine-generators in service.

A modern boiler with induced-forced draft and stokers is on "dead bank" when the forced- and induced-fans are stopped, the coal supplied at irregular intervals and the boiler kept below header pressure; that is, generating zero per cent of its maximum capacity. A boiler of the same type is on running bank when the induced-fan is running slowly or is stopped, if the chimney draft is able to produce a small draft in the furnace, coal being fed in slowly by the stoker, the boiler up to header pressure and generating about 15 per cent of its maximum steaming rating. The same boiler is brought to steaming service from a running bank when the fans are started, fuel and water supply adjusted, and the boiler is generating 65 to 100 per cent of maximum rating.

Dead banks, being relatively cold, are slow to bring to a running bank and then to steaming service. However, they are definite aids in reducing steam capacity after most of the boilers have been placed in running-bank condition. In a period of dropping load it is best to dead bank some boilers before all boilers are brought to the running-bank stage. Running bank makes poorly controlled boilers, as far as steam-pressure regulating ability goes, since it has induced- or natural-draft fires on tight stokers designed for forced draft. The fuel bed burns slowly and the steaming capacity responds very slowly to changes. Their advantage is manifest when they are operated at a continuous base-load rating of 15 per cent, ready to be brought into steaming service at short notice. It is noted that there is a big difference in the capacity of a running bank and a boiler at minimum steaming capacity. This is an inherent feature, especially of stoker-fired boilers, that requires caution in handling when operating near the boundary of the banked and steaming ranges of the work-day and holiday types of loads. Once in the steaming range, increase and decrease of steaming capacity is accomplished with ease, as only the fan and stoker speeds need adjustment. The more boilers kept in the steaming range during light station loads, the easier is steam regulation. This is the major reason for the steadiness of pressure in the normal load region.

Aside from the condition of the dead bank and running bank fires, they are also slow in coming to steaming service due to the greater density of the water in the boiler, which rapidly decreases and will spill water into the superheater and headers. Five to ten minutes may be necessary to settle the water. No banks can be made or broken without the attention of the water tender. A boiler in the steaming range gives little water trouble.

For example, it will be seen from Fig. 1 that at 12 a.m. there was a load of 100,000 kw. on the holiday curve. With an average of 10 lb. of steam per hour per kilowatt-hour, the boiler room output was at the rate of 1,000,000 lb. of steam per hour. Line 22 of the schedule, Fig. 3, shows that 20 boilers must be steaming at an average rating of 50,000 lb. each to give this output. The load, however, was dropping, and after losing 3,750 kw. between 12 a.m. and 12:13 a.m. the rate of boiler room output was decreased 37,500 lb. of steam. The boilers were on minimum steaming rating at 50,000 lb., so a running bank was made. Boiler No. 23 was thus dropped to running bank at 12,500 lb., which effected the decrease of 37,500 lb. of steam output. Line 21, corresponding to this load of 96,250, shows that the boiler output had been dropped to 962,500 lb. by taking 950,000 lb. from steaming boilers and 12,500 lb. from the banked boiler, No. 23.

The actual load curve of each specific day cannot be predetermined and hence the boilers cannot be scheduled ahead with load and time. However, a schedule made for the total range of loads used by the firemen in conjunction with a totalizing kilowatt meter will tell

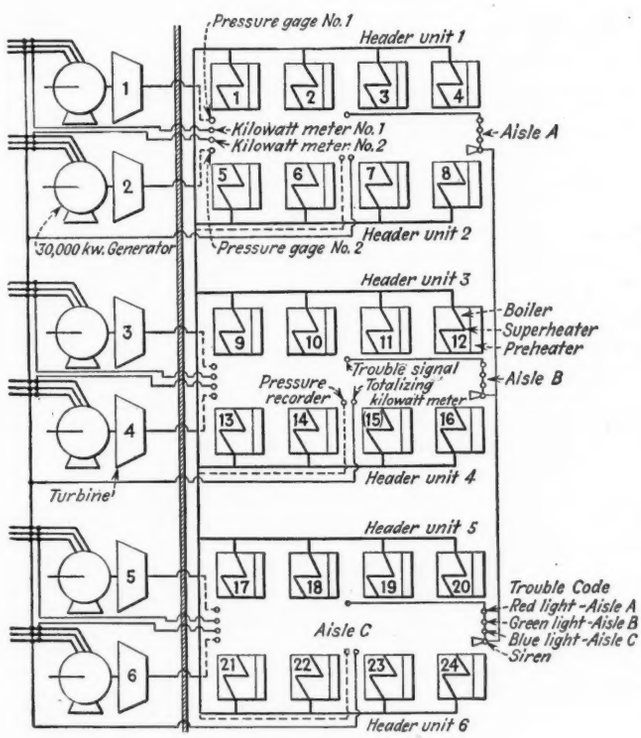


Fig. 2—Layout of the plant under discussion

what to do as soon as a load change does come and will avoid confusion among six firemen.

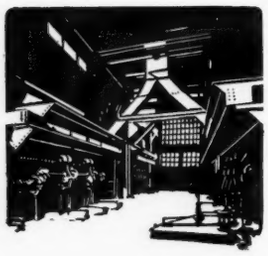
It is noted that this schedule can be used with decreasing or increasing load. The turbines, as shown by column *k*, change in the same order on decreasing as on increasing load, but possibly not at the same loads. Firemen soon learn that all must watch the totalizing kilowatt meter to change their boilers on time. This becomes easy as they know that a certain load calls for a certain boiler and they need not worry about other boilers being changed at the same time. If something happens, No. 15 boiler, which has been designated as the reserve, is

	Boilers Added			Load, Kw.-Hr.	Boilers						Turbines on Line
	Aisles				Steaming		Running Banked		No. Dead Bank	No. Burned Off	
	A	B	C		No.	Total Rating Lb. per Hr.	No.	Total Rating Lb. per Hr.			
1				20,000	0	0	16	200,000	4	4	2,3,5
2		9		23,750	1	50,000	15	187,500	4	4	
3			17	27,500	2	100,000	14	175,000	4	4	
4	5			31,250	3	150,000	13	162,500	4	4	
5		10		35,000	4	200,000	12	150,000	4	4	
6			18	38,750	5	250,000	11	137,500	4	4	
7	6			42,500	6	300,000	10	125,000	4	4	
8		12		46,250	7	350,000	9	112,500	4	4	
9			20	50,000	8	400,000	8	100,000	4	4	2,3,5,4
10	7			53,750	9	450,000	7	87,500	4	4	
11		13		57,500	10	500,000	6	75,000	4	4	
12	8			61,250	11	550,000	5	62,500	4	4	
13		14		65,000	12	600,000	4	50,000	4	4	
14	1			68,750	13	650,000	3	37,500	4	4	
15	3			72,500	14	700,000	2	25,000	4	4	
16			24	76,250	15	750,000	1	12,500	4	4	
17		(15)		80,000	16	800,000	0	0	4	4	
18				85,000	16	800,000	4	50,000	0	4	2,3,5
19	4			88,750	17	850,000	3	37,500	0	4	4,1
20			21	92,500	18	900,000	2	25,000	0	4	
21			22	96,250	19	950,000	1	12,500	0	4	
22			23	100,000	20	1,000,000	0	0	0	4	2,3,5
23				110,000	20	1,100,000			0	4	4,1,6
24				120,000	20	1,200,000			0	4	
25				130,000	20	1,300,000			0	4	
26				140,000	20	1,400,000			0	4	
27				150,000	20	1,500,000			0	4	
	a	b	c	d	e	f	g	h	i	j	k

Fig. 3—The time table, or schedule of boiler operation

ready to go into steaming service. When steam is used for purposes other than the generation of power, such as for the warming of a turbine-generator before it is placed on the system, a slight increase in capacity of each boiler will compensate for the slight increase in demand. Any other discrepancies, such as the change of the water rate with load, can well be handled in the same manner. The schedule is very flexible and can be changed when the steam foreman desires, provided the schedule of each fireman is changed in similar manner at the same time. While the whole of the schedule may be deemed too complicated for all the firemen to have, it is valuable to the steam foreman, and only columns *a*, *b*, *c*, *d*, *g* and *j* are necessary to the operating man. The confidence of the firemen is quickly won with an effective schedule.

To make schedule requires close observation, common



sense and co-ordination between the electrical, turbine and boiler room departments. The schedule really means that the correct amount of steam is being generated for each load regardless of the many conditions that affect that amount. In this schedule, 10 lb. of steam per kilowatt-hour have been taken as the water rate of the turbines. The reading of column *d* multiplied by ten would give the total output of steaming and running banked boilers. The background of the schedule should be based upon the condition of the auxiliaries, the boilers and turbines, upon the heaters in service and last-minute information from the boiler room operators. It should be made by the boiler room engineer in such a way as to fit the needs of all the holiday shifts. This would make operation smooth at shift changes, as the oncoming shift immediately would have a full picture of the boiler room situation, and instantly pick up regulation of the pressure.

Bids on Power Plant Equipment

THROUGH the courtesy of Burns & McDonnell Engineering Company, below are given bids on the power-plant equipment for the Muscatine, Iowa, municipal power house. Some of the variations in the quotations are due to lack of completeness in the bids.

BOILER

Bidder	A	B	C	D	E
Type of Boiler	Bent Tube	Cross Drum	Cross Drum	Cross Drum	Bent Tube
Working pressure	250	250	250	250	250
Heating surface, sq.ft.	10,100	10,230	9,448	10,240	10,080
Pressure drop through superheater at 200 per cent rating, lb.	2.8	4.4	7.7	5.5	1.2
Spr'heat at 100 per cent rating	120	....	103	100	135
S'prheat at 200 per cent rating	155	160	146	150	160
Cost of boiler, soot blower and superheater	$30,346	$29,593	$30,835	$30,000	$25,461

STOKER

Bidder	A	B	C	D	E
Type	Chain grate	Under-feed	Under-feed	Chain grate	Under feed
Grate area, sq.ft.	248	203	205.7	....	.....
Retorts	....	10	10	....	.....
Tuyeres	....	25	25	....	.....
Furnace efficiency, 200 per cent rating	75.4	76.9	76	73	72.5
Coal per hr. per sq.ft.	27.7	40.4	36.2	19.4	36
Draft fan, hp.	23.5	16	35	....	26
Induced-draft fan, hp	....	....	....	....	.....
Cost of stoker and draft equ'pt	$15,200	$14,300	$15,295	$14,548	$16,098

BRICKWORK

Bidder	B	C	D	E	I	J
Cost if underfeed stokers are used	$6,050	.....	$6,700	$8,420	$5,500	$5,287
Cost if chain grates	$6,325	$8,040	$9,000	$9,625	$6,000	$6,726

PIPING AND GENERAL EQUIPMENT

Bidder	K	L	M
Cost	$18,239	$19,900	$21,215

COAL HANDLING, INCLUDING BUNKER, ELEVATOR, LORRIES AND BUCKET

Bidder	N	O	P	Q
Cost	$11,440	$16,750	$8,626 (without bucket)	$12,000

ASH HANDLING, INCLUDING 30 TON BUNKERk SKIP HOIST OR OTHER DEVICES

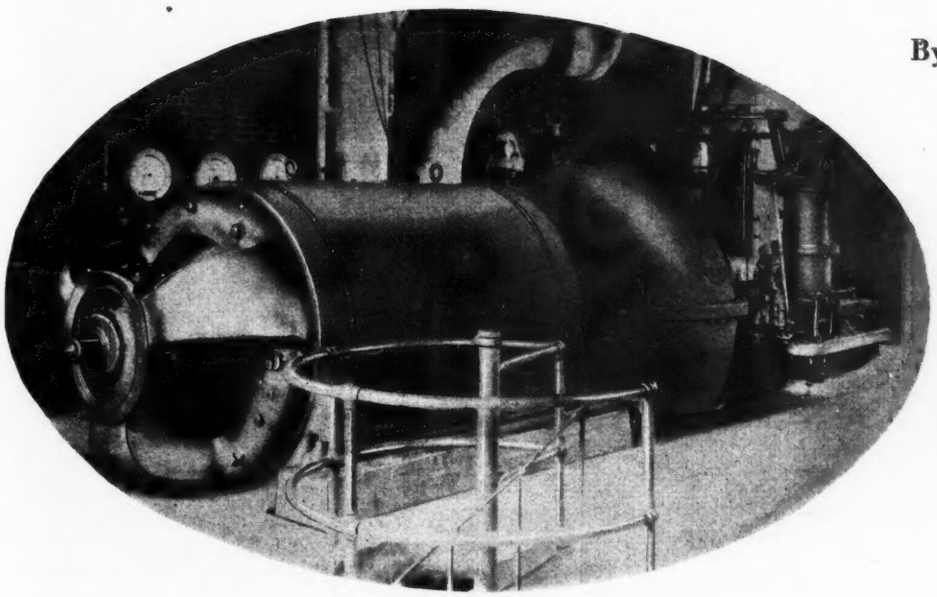
Bidder	N	O	R
Cost	$20,030	$11,400	$15,394

BUILDING

Bidder	S	T	U
Cost	$19,402	$39,941	$24,200

Governing the Operation of Back-Pressure Turbines

By R. G. STANDERWICK
General Electric Company



Non-condensing turbine arranged for exhaust pressure control

Exhaust or bled steam used for process work is generally required at constant pressure. Regulation of this pressure is made automatic by turbine controls here described

IN THE early development of the steam engine the chief aim of the designer was to prevent the engine from racing when a part or the whole of the load was suddenly removed, and so his effort was solely to control engine speed by the well-known Watt type fly-ball governor. Little thought was at first given to the available energy still remaining in the steam even at atmospheric pressure, and years passed before it was found that the efficiency of the heat cycle could be improved by higher pressures and other means.

Gradually, as the economy of the heat cycle was studied, it was found to be advantageous to allow non-condensing engines, which may have been driving generators or which were mechanically connected to feed pumps or other auxiliaries, to exhaust their steam into heaters, and so reheat the condensate from the condensers of larger engines, with considerable gain in over-all station economy.

As steam turbine design began to parallel steam engine design, the advantages of bleeding a small portion of the steam from stages above atmospheric pressure were appreciated and a further gain in economy was effected. But perhaps a greater advance in the art came with a realization that large gains in economy could be secured under conditions that permitted generating electricity from steam required for other process purposes.

So came the development of the back-pressure turbine, which, by proper selection, can be used to reduce the pressure of steam from that in the boilers to any desired value, and during this reduction to convert part of the energy in the steam into valuable mechanical and electrical power. Also, attention of turbine designers was directed toward the problem of controlling exhaust pressure in such a way that wide variations in demand for low-pressure steam could be met without causing appreciable changes in exhaust pressure.

The variable demand for low-pressure steam and consequent variable flow through the non-condensing turbine is accompanied by similar variations in the power output. The first problem was to absorb this variable turbine output. In most instances the turbines drove alternating-current generators which were phased into speed-controlled alternating-current power systems. In this way the speed of the non-condensing units was determined by the frequency of the power system, and its generator output varied with the converted energy of the steam demanded at the exhaust.

Control mechanism for such a turbine is shown in Fig. 1. The turbine shaft is equipped with a worm, meshing into a worm gear that drives a vertical shaft. On the lower end of this shaft is a main oil pump of

the gear type, which supplies the oil necessary for bearings and for hydraulic operating cylinders of the valve gear. On the upper end is an improved fly-ball governor, which, by its action in response to speed, moves a rotating pilot valve piston axially. This pilot valve is equipped with cut-off edges so related to ports in the bushing which forms its guide that high-pressure oil from the main pump is applied to a hydraulic cylinder mounted directly beside it. If the speed drops, it causes the piston of this cylinder to rise, or if the speed increases, oil, which is under pressure due to the loading spring of this piston, escapes past the lower port of the bushing, thereby causing the piston to drop.

The motion of this piston is transferred to the horizontal lever above it, to which is also attached the bushing of the rotating pilot valve serving in the usual capacity of a restoring mechanism. Motion of the piston and its lever also moves one end of a floating lever to the middle of which is attached the pilot valve of the main operating cylinder. The opposite end of the lever is attached to the main operating cylinder and serves as a restoring mechanism of the main pilot valve.

A speed governor applied in this way to a turbine valve gear insures governor accuracy, since no work is required of the governor to indicate its speed position to the main pilot valve. Furthermore, the relative power of the governor is magnified several thousand times to overcome possible reaction of the main pilot valve or friction of the operating mechanism.

To change the speed of such a turbine it is merely necessary to lengthen or shorten the distance between the governor pilot bushing and the restoring lever. This is accomplished manually by turning the threaded rod relatively to the pilot bushing, or by causing a remotely controlled synchronizing motor to turn the bushing relatively to the rod.

When the turbine has been brought up to speed and its generator phased with the system, the pressure at the exhaust may be regulated either manually or automatically by the mechanism shown in the diagram, Fig. 2.

Here a pressure diaphragm, connected by a pilot line to the exhaust piping, is spring-loaded, the upper end

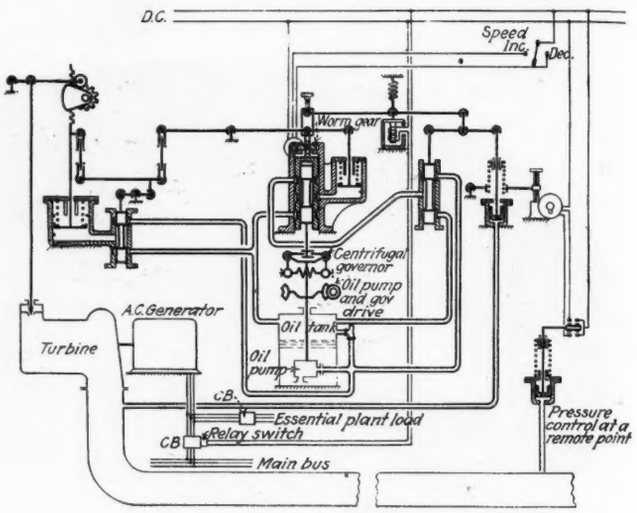


Fig. 2—Diagram of a back-pressure and centrifugal governor

of its loading rod being attached to one end of a floating lever, the opposite end of which supports an auxiliary pilot valve. The center of the lever is supported by a second lever, whose opposite end is attached to the top of the speed pilot bushing and serves to restore the auxiliary pilot by motion of a small hydraulic or relay piston.

High-pressure oil in this case is applied to a stationary bushing that surrounds the auxiliary pilot and, after passing this pilot valve, is caused to pass around the speed pilot before entering the hydraulic relay cylinder.

As the exhaust pressure of the turbine varies due to changes in demand for process steam, the diaphragm rises or falls and causes the auxiliary pilot to admit or extract oil from the relay cylinder, which effects an opening or closing of the main valve gear.

Under these conditions the speed governor is normally out of action, as shown in Fig. 2, so small variations in frequency do not affect the position of the main steam valves unless an excessive turbine speed results from an extremely high system frequency or from accidental opening of the generator oil switch that ties the turbine-generator to the speed-controlled system. Only under this condition will the speed governor cause its pilot valve to assume entire control of the valve gear and prevent the speed increasing to a point where the emergency governor operates.

PRESSURE SETTING of such a governing mechanism is changed by varying the diaphragm's loading spring tension. This may be done either by hand or, remotely, by a motor, as shown in the illustration.

Remote pressure setting is of great value, because in this way pressure drop in the exhaust line may be compensated for and a substantially constant pressure maintained at the distribution point where the pressure regulator is installed, or adjustments in pressure setting

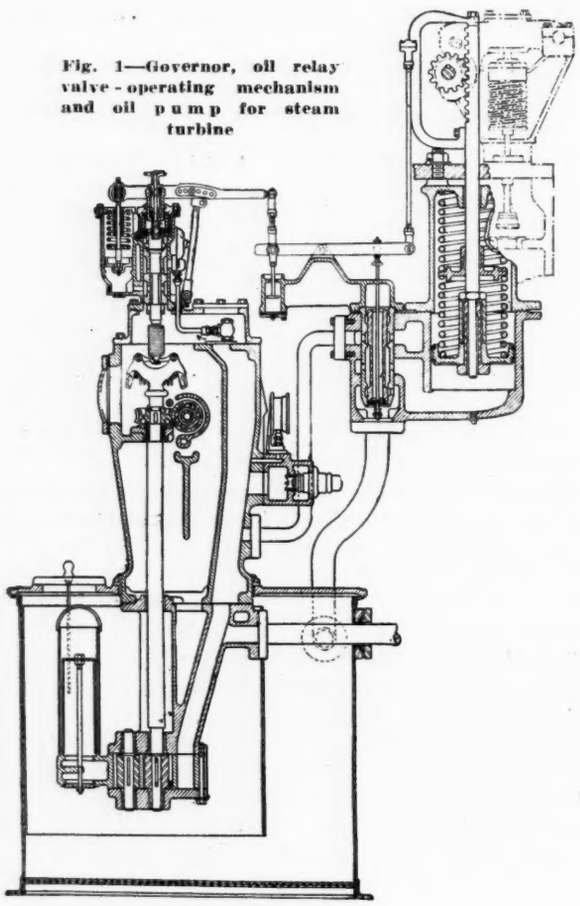


Fig. 1—Governor, oil relay valve-operating mechanism and oil pump for steam turbine

may be made remotely as demanded by requirements of production.

The head-piece photograph shows a 2,500-kw. non-condensing turbine arranged for exhaust-pressure control as described, and also for automatic extraction of large volumes of steam at an intermediate pressure with full automatic control. The mechanism is designed so that variations in demand for extracted steam are satisfied by opening or closing the high-pressure valve gear, without disturbing the flow or pressure of steam at the exhaust. Variations in exhaust demand are satisfied by opening or closing both the high-pressure and the intermediate valves, without disturbing the flow or pressure of steam at the extraction point.

It is desirable at times to readily change from pressure control to speed control. This is provided by the solenoid shown in Fig. 2, which changes the positions of the levers upon being energized or de-energized.

A case in point is when a back-pressure turbine is desired to serve as a stand-by unit to take the essential load of a plant in event of an interruption of supply from other generators.

The power buses must be so arranged that the essential load can be segregated from the total load, and a device must be used which will automatically bring about the required readjustment.

A DEVICE that has given satisfactory results is shown in Fig. 4. It consists of a separately excited synchronous motor driving a standard turbine centrifugal governor within a casing, and an oil relay to actuate a series of switches. The synchronous motor operates from the system bus. In the event of trouble on the system, frequency generally falls, and this change of speed causes the motor-governor device to operate a switch which places the essential station load on the back-pressure turbine. Another switch opens the circuit energizing a solenoid, Fig. 2, changing from pressure control to speed control of the turbine.

Fig. 3 shows, in section, a non-condensing turbine with automatic extraction at two intermediate pressures. Here again variations in demand for steam at any one of the extraction points or at the exhaust are satisfied without disturbing the others. A device is also provided whereby at the moment of transferring from pressure control to speed control any pre-determined load may be carried, the speed governor being adjusted to maintain 60 cycles on the system. In this way such a turbine can be relied upon to act immediately as a stand-by unit and so protect the essential load of the power plant.

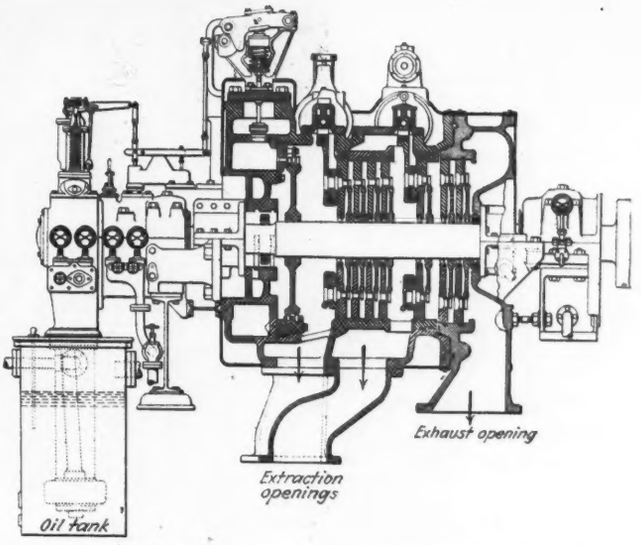


Fig. 3—Section of steam turbine arranged for back-pressure governor and steam extraction at two pressures with automatic control

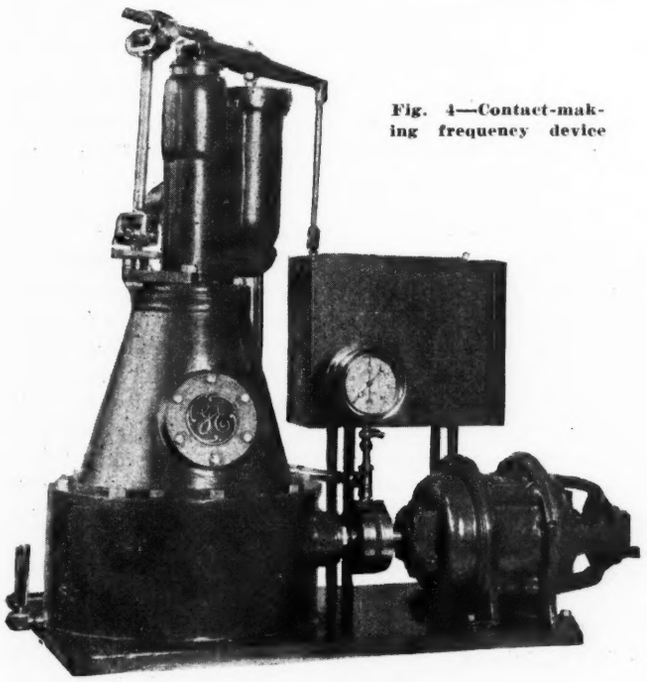


Fig. 4—Contact-making frequency device

Soluble Detectives

THE hydraulic engineer's "salt method" of measuring water flow has close analogies in other engineering fields. All of these employ a "soluble detective." The hydraulic engineer adds salt to a stream at a measured constant rate. Down stream he draws a sample for chemical analysis. If the salt is added continuously and the mixing is complete, the quantity of salt determined in a sample of given size will be a precise measure of the rate of water flow. For example, if a one cubic-foot sample shows one hundredth of a pound of salt and if salt is added up stream at the rate of one pound per second, the flow must obviously be 100 cu.ft. per second.

Although most engineers do not think of it that way, the same principle is involved when chimney losses are computed from the percentage of CO_2. Neglecting CO and grate loss, a given weight of a given fuel will produce a fixed volume of CO_2 regardless of the amount of excess air supplied. With this CO_2 goes all of the nitrogen and the unused oxygen. Now, as the excess of these heat-carrying gases increases, the CO_2 will become a smaller and smaller percentage of the total. Yet, the actual volume of CO_2 produced from a given amount of coal does not change.

Suppose, in the case of water measurement, that the flow increases while salt is fed in at a constant rate. The amount of salt in a given sample will necessarily fall. In the same way an increase in the air supply while coal is burned at a constant rate will decrease the percentage of CO_2.

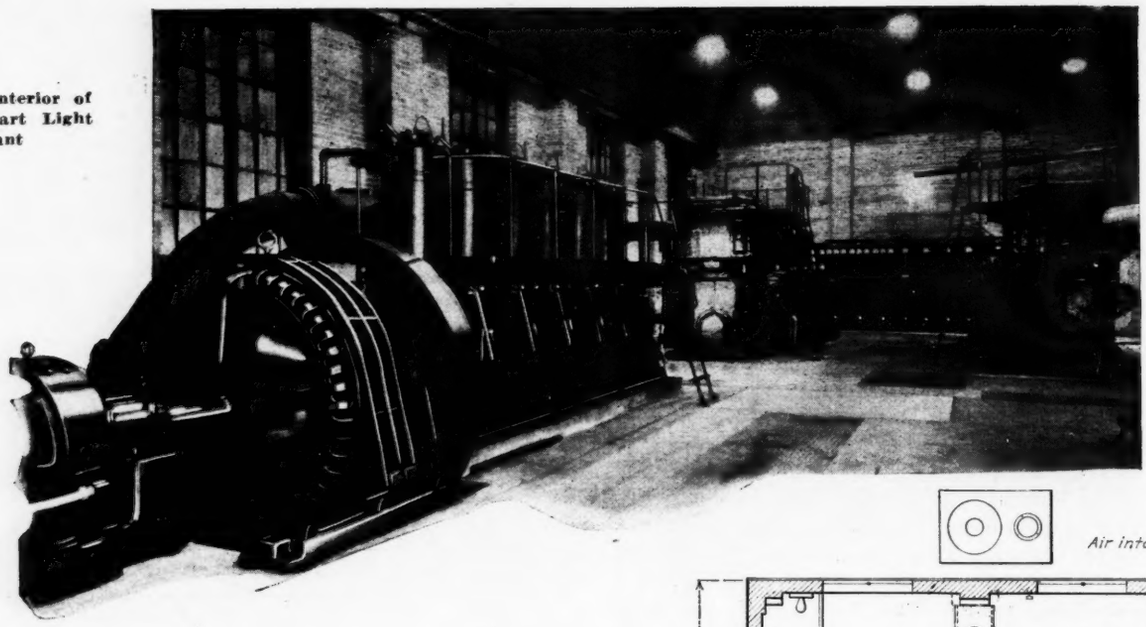
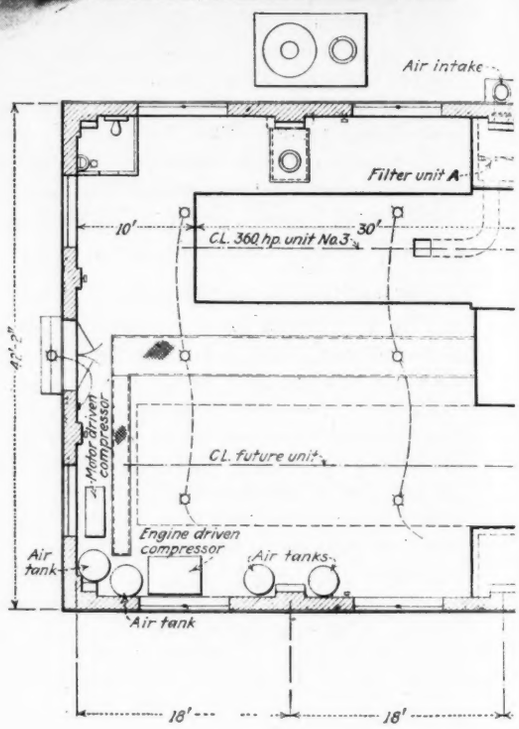


Fig. 1—Interior of new Hobart Light plant



Financing

A SMALL TOWN'S POWER SUPPLY

By C. F. LAMBERT
Burns & McDonnell Engineering Company

THE City of Hobart, Ind., just southeast of Gary, has a population of 7,000, but the area within the corporate limits is sufficient to take care of a population of 125,000. Natural conditions and the proximity to Chicago make the possibilities of such a growth very probable.

The city had long owned its water plant when in 1893 it voted $22,000 to build a light plant. While these utilities had been operated profitably since then, the income had been used for general city purposes and no reserve had been set aside for depreciation and to take care of enlargements when required. The laws of Indiana limit greatly the bonding power of municipalities, and this was a further handicap to the plant. The result was that equipment purchased was not selected on the basis of its adaptability to the requirements, but upon the kind of deferred-payment terms offered by the seller.

The year 1924 found the plant greatly in need of improvements and enlargements. City officials became discouraged, and when an offer was made by the Northern Indiana Public Service Company to purchase the plant for $90,000 it was accepted. A referendum was called, however, and the proposition was turned down by a vote of 153, there being 626 votes for the sale and 779 votes against it.

Early in 1928 plans were made to build a filtration plant. Water was taken from Lake George, located within the city limits. Some form of purification was needed. At this time there was again agitation for selling the plant. There was also considerable comment in favor of securing water from Lake Michigan. In June, 1928, on demand from some citizens, bids were received for the plant, including an agreement to obtain better water. Bids ranged from $210,000 to $510,000, depending upon whether water was to be secured from Lake Michigan. The council finally accepted an offer of $375,000, with an agreement by the purchaser to furnish Lake Michigan water. Again a petition for an election was issued and again the proposition was defeated.

John Gregg, superintendent of the plant, on his own initiative and with his personal guarantee for payment of services, asked the engineering firm of Burns & Mc-

Donnell of Kansas City to make an investigation of the properties and determine what was needed and what the cost would be.

THE ENGINEERS found the water and light plants to be in bad shape. Equipment was old and extremely wasteful of coal. A considerable portion of the equipment was not paid for. The legal debt limit of the city was about $100,000, and there were outstanding obligations equaling almost $160,000.

The engineers recommended a new power plant, using Diesel engines and entirely discarding the old plant, which also included some central heating in its output. The use of Lake Michigan water was not proposed, on account of the high first cost and also because it was found to be as highly polluted as the Lake George water.

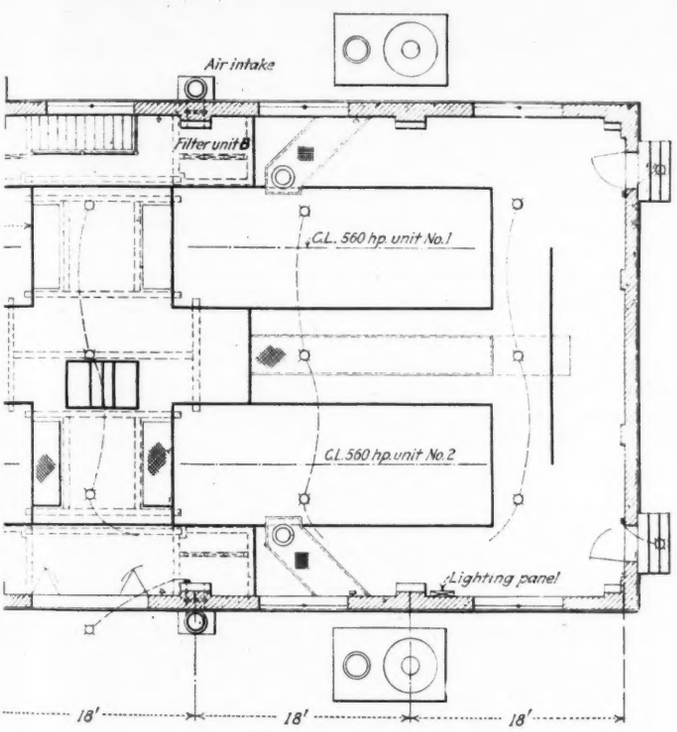


Fig. 2. Plan view of the power plant layout

The estimate of improvements recommended are given in Table I:

TABLE I—LIGHT AND WATER PLANT RECOMMENDED

Lighting System		
Land	$5,000	
Power-plant building, crane, etc.	27,500	
Equipment, including two 600-hp. and one 400-hp. oil engine units, with air filters, air silencers, oil storage tanks, switchboard and all accessories	210,613	
Car transformers, meters and services	9,720	
New primary and secondary lines	20,865	
Rebuilding old lines	19,520	
Engineering and supervision	24,923	
Total light		$318,141
Waterworks System		
Land	$5,000	
Intake	7,590	
Suction line	2,500	
Filters, capacity 1,000,000 g.p.d.	62,061	
Pumps:		
Low service, 500 and 700-g.p.m. capacity; high service, 500, 700 and 1,000 g.p.m. capacity	7,350	
Tower and tank, 200,000 gal., on 150-ft. tower	18,054	
Distribution system	80,470	
Engineering and supervision	15,530	
Total water		$198,465
Total light and water		$516,606

How to raise funds to make necessary lighting and water system extensions is a problem faced by many municipalities that have reached their bonded debt limit. Hobart, Ind., overcame this difficulty by setting up a financial plan that did not require the investment of a cent of the town's cash.

▼

It was known that it would be impossible for the city to finance the building of these plants, as it was already beyond its debt limit, therefore estimates were made to determine how profitable the plants would be. Using existing rates and taking existing income from consumers and adding thereto a fair charge for street lighting and water pumping, it was found that the statement for the first year would be about as given in Table II:

TABLE II—ESTIMATED PLANT OPERATION

Revenue:		
Consumers	$76,200	
Street lights	7,140	
Water pumping	10,000	
Total		$93,340
Expenses:		
Fuel and lubricating oil	10,360	
Labor	19,680	
Cooling water	200	
Maintenance	5,000	
Supplies	2,400	
Total		37,640
Operating profit		$55,700
Interest, 6 per cent		19,088
Balance to apply on principal		$36,612

Thus it was shown that even with no increase in business the plant would pay for itself in less than nine years. With the increase in business which was sure to occur, it was seen that the light plant would pay for itself in much less time.

In the water department a similar condition was shown, although, as was expected, the profit was not so great and it would take a longer time to pay out. With no increase in business it would take 20 years to pay off the water plant, for the estimated balance to apply on the principal was only $9,842. However, it was certain that with filtered water the consumption would increase materially and with a modern water and light plant it was expected that the population of Hobart would increase rapidly.

WITH THE engineer's report in his possession the superintendent set about to find some method of financing the improvements and to get a definite proposal to present to the city officials. Several contractors and manufacturers were interviewed, but no satisfactory proposal was received for handling the complete water or light improvements, until finally Fairbanks, Morse & Company of Chicago expressed a willingness to handle the complete light plant.

The desire was to have someone build a plant and operate it, the revenues, after deducting operating charges, interest and a reasonable management fee, to apply to the credit of the city. In this way the city would eventually own its own new plant, making the future earnings collateral for money needed at present.

This meant that it would be necessary to give a franchise to the operating company, which would have to

buy or lease the existing lines to complete the system.

In November, 1928, the company presented a definite proposal to the city officials. It agreed to build an electric light plant and system for $318,000. It also agreed to give the city $60,000 for existing lines. They were to organize a separate Indiana corporation to operate the plant. Out of the earnings they were to deduct 6 per cent interest and a reasonable management fee, and the remainder to go to the credit of the city. When this credit equaled the total of the $378,000, the title to the plant was to be transferred to the city and all franchise rights released. It was finally agreed that the proposal would be accepted, but only if a similar arrangement would be made on the water.

In November, 1928, the company made another proposal, to build the light and water plants according to the reports of the engineers for $516,465 and to pay the city $100,000 for the existing light and water lines. This $100,000 would enable the city to pay off most of its debts and bring it back within its legal debt limit.

The proposal was accepted and a franchise ordinance was passed. It was also necessary to pass an ordinance concerning the sale of the entire electric distribution system and the entire water distribution system to this company for $100,000.

The franchise ordinance gave the rates to be charged, which were less than those then in force. It was agreed that the franchise should not be binding until after the sale contract should have been ratified and approved by the State Public Service Commission. In December, 1928, the ordinance became a law subject to the approval of the Public Service Commission and the Attorney General.

In Indiana the sale of a municipal utility plant is subject to a referendum, but the sale of a distribution system is not. The only part to be sold was a distribution system, but it was decided that if a referendum were called it would be best to let it go to an election. However, the people were convinced of the desirability of the plant and no call for an election was filed. In January, 1929, the Public Service Commission's engineers approved the plans and estimates.

At last, it seemed as though everything were settled. Then a hitch occurred. The Public Utilities Commission had signified its willingness to approve the proposition it it met the requirements of the utilities laws of the state, and some of the members remarked that it was the best proposition for any city that had ever come to their attention. In order that there should be no question of debt-limit evasion the Attorney General asked that part of the franchise be placed in a separate contract. In February, 1929, the council again passed the necessary ordinances, the proposition was again presented to the Public Service Commission and the Attorney General, and was approved by them.

Immediate steps were taken to organize the Hobart Light, Heat & Water Company, and engineers began preparation of detailed plans and specifications.

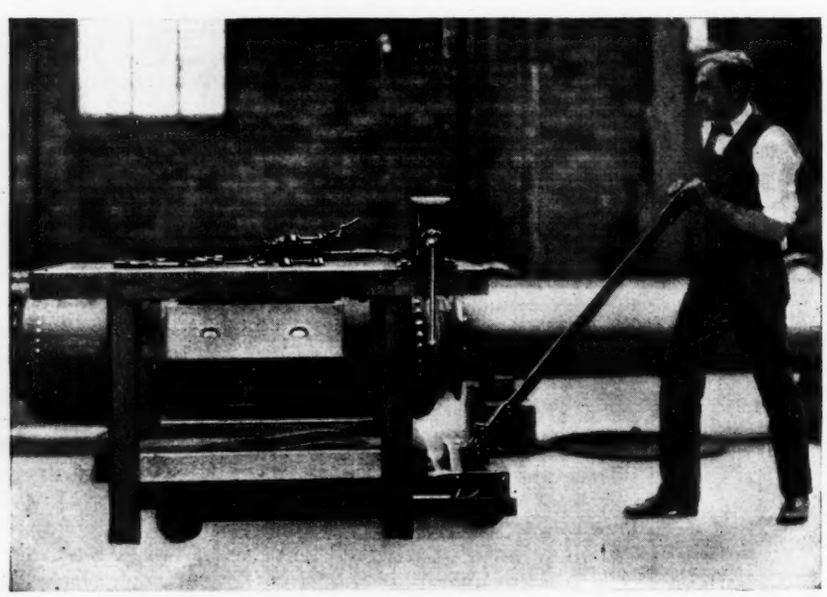
About April 1, 1929, the new company took over the operation of the systems, the city still operating its old plant and the new company purchasing its current from this plant. Immediate construction was begun on the new electric distribution lines and water mains. In July, 1929, the new rates were put into effect. In October, 1929, the city sold its old plant to be operated by a private party as a central heating plant. Last December the new generating plant was completed and placed in operation. Plans for a filter plant have been approved by the State Board of Health, and it will be completed early in 1930.

▼ ▼ ▼

Another Kink From Lehigh

RECENTLY *Power* published an interesting practical kink obtained in an interview with Prof. F. V. Larkin, who heads the department of mechanical engineering at Lehigh University, Bethlehem, Pa. It was a rapid method of drilling large holes in concrete floors. Using a special machine originally designed to take core samples of concrete highways, Professor Larkin was able to drive 8-in. holes through a 9-in.-thick concrete floor in twenty minutes each.

Here is another kink from the same source—this time a portable work bench. The lower shelf of the bench, as shown in the photograph, is placed at such a height that the familiar device shown for handling crates and tote boxes can slide under and pick it up in a few seconds. Thus the bench can easily be taken to the job when, as is often the case around the laboratory and the plant, the job cannot be carried to the bench. This work bench, specially designed as standard equipment for the new Packard engineering laboratory, has other features of interest to the practical man. Fabrication of the frame by welding together light structural steel members insures strength and rigidity. The 4-in.-thick maple top is built of strips placed on edge and tightly held together by through bolts with spring washers.



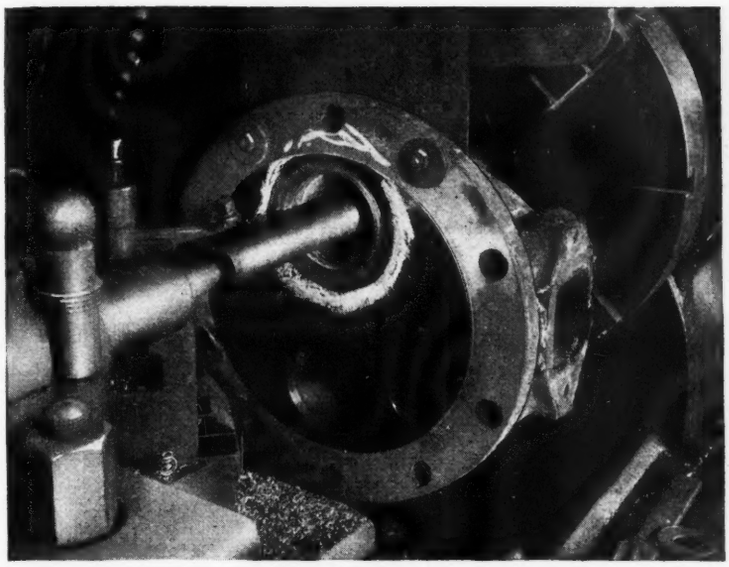


Fig. 1 — The head on the lathe after being machined to a perfect seat

Rebuilding Worn Valve Seats by Arc Welding

THE BEST method of repairing worn valve seats has always been a more or less debatable question, but the use of arc welding, as shown in the accompanying photographs, is probably the fastest method, and in most cases the cheapest, especially on large heads.

The heads shown in these photographs are those of a Bruce-Macbeth 165-hp. gas engine. The exhaust-valve seats on these heads were worn down from refacing, and were built up and put into service by the National Zinc Company of Bartlesville, Okla., using the electric arc to deposit the metal.

In Fig. 2 the process of building up the valve seats is shown. The head on the left in this photograph has been ground out to approximately one inch below the original surface of the seat, and is ready to be built up by the electric arc. The head on the right has been built up and is ready for machining.

The finished head is shown in Fig. 1. This has been built up and machined out to a perfect seat on the lathe.

In building up the valve seat the metal is put on in two layers. The first is burned well into the cast-steel head, thoroughly peened and all slag and oxide removed. This leaves the weld clear and bright for the second layer. After the second layer is put on, the seat is machined to size as shown in Fig. 1.

The photographs and information were furnished by the Lincoln Electric Company.

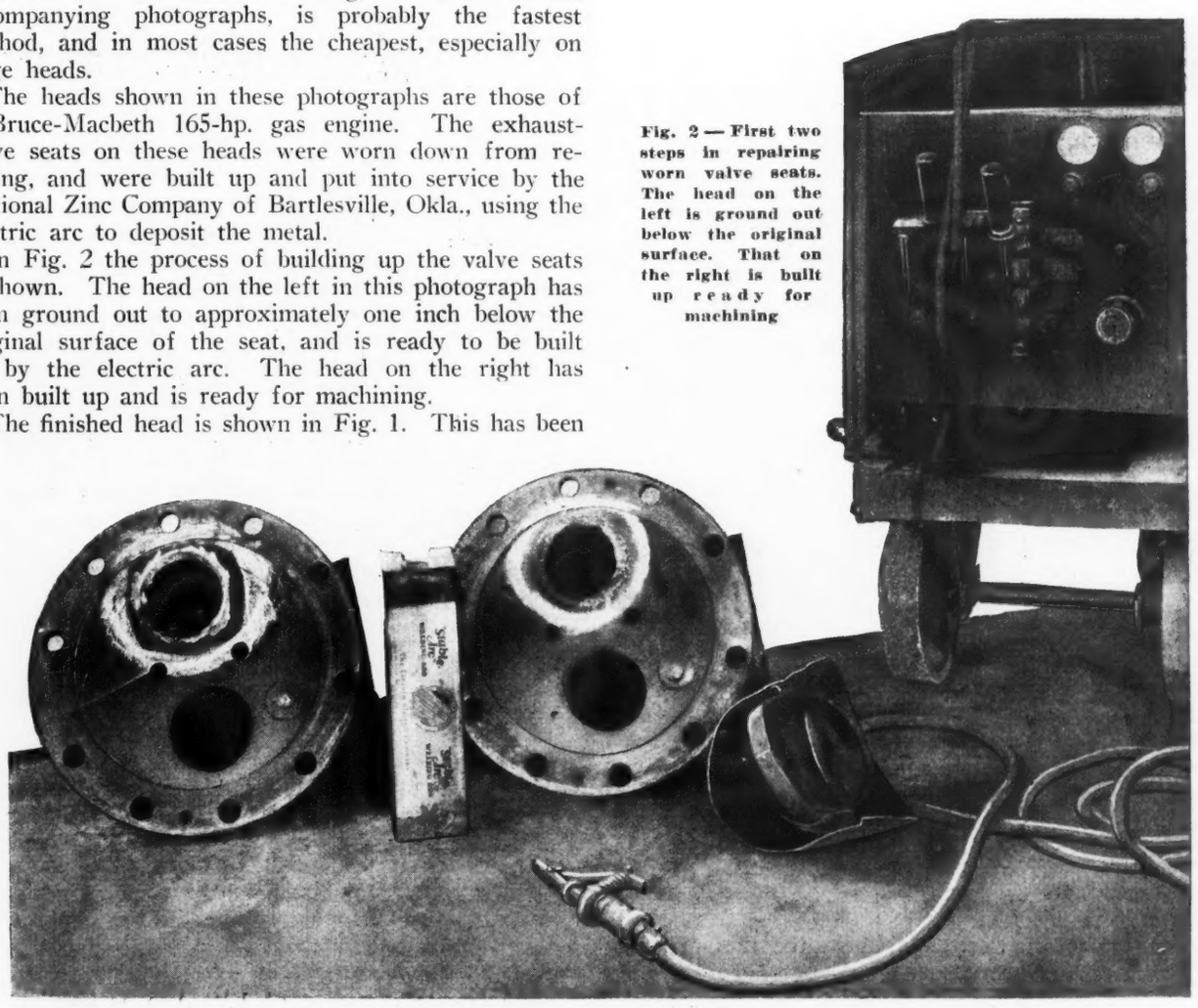
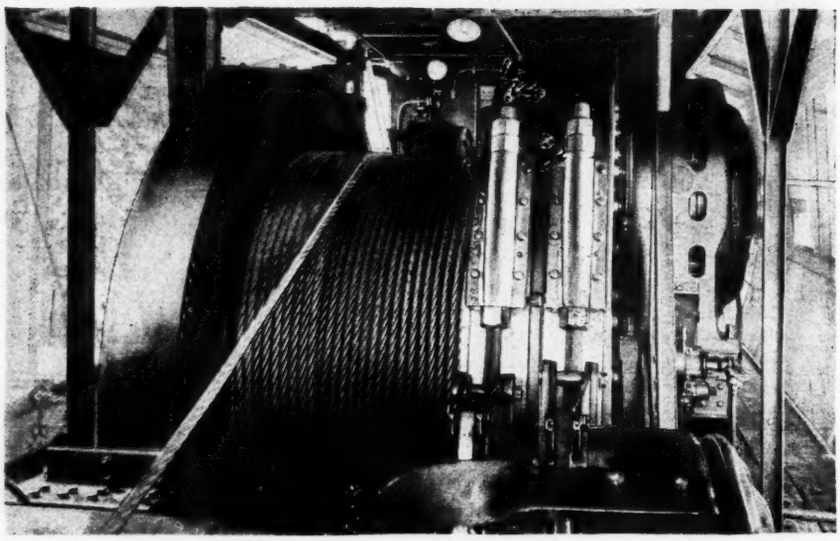


Fig. 2 — First two steps in repairing worn valve seats. The head on the left is ground out below the original surface. That on the right is built up ready for machining



Unbalanced-slope hoist operated by 750-hp. induction motor

R. F. EMERSON
Industrial Engineering Dept.
General Electric Company

Tells How to Figure

MOTOR SIZES

for Hoist Service

Hoists are required to handle loads under a variety of conditions, each of which has an effect on the size of the motor required for the service. In this article applications usually encountered by engineers are considered, formulas are given for each and problems are worked to show how to apply the methods to determine motor sizes

IF A MOTOR is geared to a hoist and is raising a load vertically at a given speed, the power demanded of the motor depends on the weight lifted; the speed at which the load is raised; and the friction losses in the gearing, roping, drums, sheaves and other parts. Whether the load is raised vertically, as with the hoist motion of a crane; or, moved horizontally, as when a winch pulls a car on a track; or, if the load is moved on a slope, that is intermediate between vertical and horizontal motion, the same basic formula is used for calculating the power:

$$Hp. = \frac{P \times F.P.M}{33{,}000 \times E} \qquad (1)$$

where

$Hp.$ = horsepower required of the motor doing the work,
P = pull on the rope attached to the load,
$F.P.M.$ = speed of the load in feet per minute,
33,000 = a factor to reduce the result to horsepower,
E = efficiency of the mechanism between motor pinion and the load.

If a car is moved up an incline, the rope pull P is composed of a pull due to the car-wheels' friction, rope drag, etc., plus the effect of gravity. If the lift is free vertically there is no rope pull due to the friction of car wheels, flanges and journal bearings, because the load is hanging in the air and the total pull P is caused by gravity. On the other hand, if a car is on a horizontal track the effort on the rope is to overcome car friction and there is no gravity pull. If the grade is between vertical and horizontal the value of P will comprise both friction and gravity.

If a motor hoists a certain load vertically, the power it exerts can be obtained from the formula:

$$Hp. = \frac{W \times F.P.M.}{33{,}000 \times E} \qquad (2)$$

where

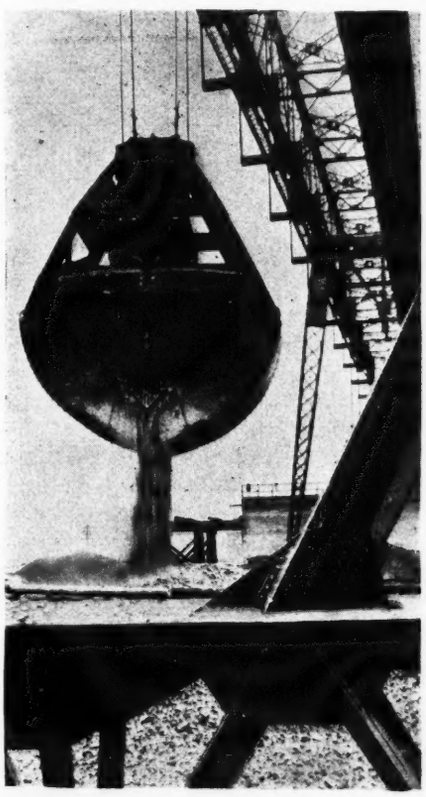
W = rope pull, in pounds, due to weight of load hoisted,
E = efficiency of the hoist between motor pinion and the load. (For a double gear reduction, this value may be around 85 per cent. If there is some roping from the drum to the hook, load, allow about 98½ per cent efficiency per sheave.)

For example, a weight of 10,000 lb. is hoisted at a

speed of 1,000 *F.P.M.* and the efficiency from the motor pinion to load equals 85 per cent, then the horsepower required is

$$Hp. = \frac{10{,}000 \times 1{,}000}{33{,}000 \times 0.85} = 356.5$$

If a car is driven on a level track, either by a motor geared to the axle or by means of a haulage rope with the motor driving a winding drum, there will be no gravity load to consider. The load will result from car friction, which consists mainly of the friction in journal bearings, binding of wheel flanges on the rails, windage, and other factors. Experience has shown that this friction load may vary from 5 to 6 lb. per ton weight of car and load for railroad cars having well lubricated journals and running on heavy clean rails, up to 50 or 60 lb. for small larry cars with a short wheelbase running on light dirty rails on a poor roadbed. A good average for industrial machines, such as mine locomotives, is about 20 lb.



Ten-ton grab bucket on a coal bridge, a good example of a free load lifted vertically

per ton. The horsepower required for propelling is obtained by using a formula

$$Hp. = \frac{(T \times F)\ F.P.M.}{33{,}000 \times E} \qquad (3)$$

where

T = weight of the car and load in tons,
F = friction in pounds per ton.

For example, a car and its load weighing 5 tons is pulled at a speed of 1,000 *F.P.M.* by a winch, then the power required is

$$Hp. = \frac{5 \times 20 \times 1{,}000}{33{,}000 \times 0.85} = 3.56 \text{ horsepower}$$

A slope hoist involves a combination of hoisting vertically, Formula 2, and propelling horizontally, Formula 3. The rope pull comes from two sources: First, gravity due to grade, and secondly, from car friction. The formula for a slope hoist is

$$Hp. = \frac{[(W \times P) + (T \times F \times Cos\ \phi)] \times F.P.M.}{33{,}000 \times E} \qquad (4)$$

where

W = weight of load in pounds,
P = per cent grade,
T = weight of load in tons,
F = friction in pounds per ton,
$Cos\ \phi$ = cosine of the angle between the slope and the horizontal.

For example, assume a car and its load weighing 5 tons is to be hauled up a slope making an angle of 30 per cent[1] (about 18 deg.) with the horizontal, then the power required is

$$Hp. = \frac{[(5 \times 2{,}000 \times 0.3) + (5 \times 20 \times 0.95)] \times 1{,}000}{33{,}000 \times 0.85} = 110$$

In the case of a slope hoist operating with a balanced load, one car ascends the grade while another descends. This is accomplished by having two cars, one attached to each end of a cable that makes a number of turns around a power-driven head sheave. A formula can be used to obtain the power required to operate this hoist. The horsepower can be calculated separately for each of the two loads, and the difference between the results represents the power to be furnished by the motor.

A somewhat simpler method is to calculate each of the two rope pulls at the head sheave, subtract the results and substitute this for P in Formula 1. Assume that a loaded car weighing 5 tons is hoisted up a 30 per cent grade at 1,000 *F.P.M.*, while an empty car weighing 2 tons is being lowered down a 20 per cent grade at the same speed. Since 5 tons is being hoisted on a 30 per cent grade, the rope pull equals the effort to overcome the effect of grade plus the friction, which gives:

$5 \times 2{,}000 \times 0.30 = 3{,}000$ lb. pull, grade effect,
$5 \times 20 \times 0.95 = 95$ lb., friction
3,095 lb., total pull to hoist.

Since two tons is being lowered on a 20 per cent grade, the results are:

$2 \times 2{,}000 \times 0.2 = 800$ lb. pull, grade effect,
$-(2 \times 20 \times 0.98) = 39$ lb. pull, friction,
761 lb. pull at the head-sheave end of cable to lower.

It should be noted that on the hoisting side the pounds pull due to grade effect is added to the pull due to friction. On the lowering side the rope pull at the head sheave is diminished by the friction, so the friction load is written with a minus sign and is subtracted from the grade effect.

The value for P in Formula 1 will be the difference between the rope pull on the hoisting side and the rope pull on the lowering side, or 3,095 — 761 = 2,334 lb. net pull. Substituting in Formula 1 we have:

$$Hp. = \frac{2{,}334 \times 1{,}000}{33{,}000 \times 0.85} = 83.1.$$

If the loaded car is being lowered instead of hoisted, the gravity effect of the load tends to cause the motor to overspeed, where the friction effect will tend to retard the car, therefore the load tending to overspeed the motor is 3,000 — 95 = 2,905 lb. The pull due to

[1]Note: Per cent grade is obtained by dividing the vertical rise by the length of slope, otherwise known as the sine of the angle between slope and horizontal.

the empty car is 800 + 39 = 839 lb. Then the net pull at the head sheave tending to overspeed the motor is 2,905 — 839 = 2,066 lb. net pull. Substituting in Formula 1, we have:

$$Hp. = \frac{2{,}066 \times 1{,}000 \times 0.85}{33{,}000} = 53.2, \text{ regenerative.}$$

This means that the motor acts as a generator, pumping current back into the line and causing it to produce a braking effect, which is possible with a shunt-wound direct-current motor or an induction motor. This is also possible with a compound-wound motor, but there may be dangerous overspeeding unless the series winding is cut out of circuit after the motor is started. A direct-current series motor cannot be used for regenerative braking unless it has a specially designed control, because a motor of this type will race and destroy itself if not regulated by its load or by other means.

The foregoing calculations disregard the effect of the weight of the haulage cable or dragging of the cable.

All of the discussion so far is based on the assumption that the load is already up to speed. The power obtained by each of the formulas is that required to keep the load going and does not take into consideration the power to accelerate the load from rest to speed.

Accelerating from rest, the load will be as expressed in Formulas 1, 2, 3 or 4, as the case may be, plus an additional load which lasts only during the acceleration period. This additional load can be calculated from the formula

$$Hp.\text{-}T = \frac{WR^2n^2}{448\,t} \qquad (5)$$

where $Hp.\text{-}T$ = horsepower-torque of acceleration exerted at motor pinion,
WR^2 = moment of inertia of the load, gears, motor rotor and other parts that must be accelerated from rest, all resolved back to the motor armature,
n = revolutions per second of motor rotor,
t = time in seconds required to accelerate the load up to speed,
448 = a constant.

The inertia of the load may be changed into flywheel effect, effective at the motor pinion by the formula

$$WR^2 = \frac{W}{e}\left(\frac{F.P.M.}{R.P.M. \times 6.28}\right)^2 \qquad (6)$$

where W = weight in pounds of load moved,
$F.P.M.$ = speed in feet per minute of load moved,
$R.P.M.$ = speed in revolutions per minute of motor,
e = efficiency of the mechanism between the motor pinion and the load.

Consider the problem of hoisting 10,000 lb. 1,000 ft. per minute, using a 600-r.p.m. motor. As previously determined, 356 hp. is required to lift the load. This will give the manufacturers some idea of the size of the motor needed, so that an estimate of the WR^2 of the rotor can be determined.

By Formula 6, the flywheel effect of this load at the motor pinion is:

$$WR^2 = \frac{10{,}000}{0.85}\left(\frac{1{,}000}{600 \times 6.28}\right)^2 = 823$$

Assume that the flywheel effect of the gears, pinions, drums and other parts, as given by the hoist builder, is 40,000 and the gear reduction between motor pinion and rotating hoist parts is 25 to 1. Then $WR^2 = \left(\frac{1}{25}\right)^2 \times 40{,}000 = 64$, because the effective WR^2 at the motor pinion varies as the square of the speed ratio.

Assume that the manufacturer gives the WR^2 of the motor's rotor as 3,820. Then 823 + 64 + 3,820 = 4,707. This is the total WR^2 of all moving parts effective at the motor pinion, and when substituted in Formula 5 gives, if the load is accelerated in 7 sec.:

$$Hp.\text{-}T = \frac{4{,}707 \times (10)^2}{448 \times 7} = 151$$

Then 356 + 151 = 507 horsepower-torque and represents the average power that the motor must exert for 7 sec. while accelerating the load. This value of 507 decreases to 356 after the speed reaches 1,000 feet per minute.

If the hoist in question operates infrequently, a 350-hp. intermittent rated motor can do the work. If the hoisting distance is short, so that the accelerating period is frequently repeated and thus forms a large percentage of the total-duty cycle, then the heating of the motor must be checked.

Preventing Accidents in Hydro Plants

SAFETY FIRST is only another way of saying forethought first. Before undertaking a piece of work, think about the danger and the precautions necessary to prevent an accident. Many preventive measures become permanent fixtures of the plant and equipment. In hydro-electric plants one of the largest elements of danger is slippery surfaces. Many surfaces are continuously wet. When inspecting the inside of flumes, penstocks and waterwheel casing, there is always the danger of slipping. The shape of many of these surfaces is such as to make them dangerous to work upon, and particular care should be taken to prevent accidents.

Wherever workers have to climb in and out of places, such as wheel pits and flumes, good permanent ladders should be installed. Although these are safer than temporary ladders, the wet, slimy condition they frequently are in makes them dangerous, too, unless cleaned before using.

Outside the plant during the winter time, in cold climates, ice makes dangerous conditions for inspecting the various structures. All walkway should be equipped with good handrails, they should be kept free of ice and snow, and, when necessary to prevent slipping, the surfaces should be sanded. Where there is danger of falling into the water, permanent ladders or other means should be provided so that the victim may get out easily.

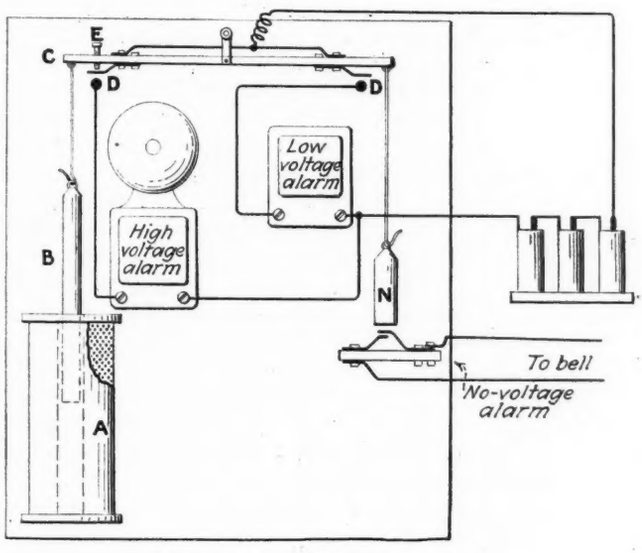
Hazards exist in the operation of the equipment. One group of these is the danger of someone tampering with equipment that is being worked upon. All gates that control the water into tunnels or conduits should be arranged so that they can be locked in either the open or the closed position. The latter is of particular importance when attendants are making inspections. All inspection work should be done on a clearance system. A clearance should be issued to the man in charge of the job, and the equipment so locked that it cannot be operated until cleared by those working on it. On impulse-type wheels do not depend on the needle valves for keeping the water out of the wheel casing. These valves are part of the unit and should be taken out of service with it, by closing the main valve.

. . . RIGHT OUT OF THE PLANT . . .

High, Low, and No-Voltage Alarm

THE ILLUSTRATION shows an improvised triple alarm system to give warning of an abnormal rise or reduction in voltage or a complete failure of power. *A* is a solenoid having 6,000 turns of No. 28 d.-c.c. magnet wire. Conductors are attached to its terminals and it is plugged into the system on which it is to be used. In this case it was 120-volt, 60-cycle alternating current. No lamp or other resistance is used in series with it, although this might be necessary with direct current. The core is of annealed iron wire No. 20 B.W.G. One hundred pieces eight inches long are bound tightly together, then lapped with friction tape and varnished. For hanging the core, a piece of the wire twenty inches long is put through the bundle until a loop remains at one end and enough protrudes at the other end to pass through two holes in a metal disk and be twisted together.

The core hangs from a beam *C* which carries a spring on the lower side at each end. The springs are in electrical contact with each other and with a flexible lead located near the center of the beam. Below each spring is a carbon pencil taken from a flashlight dry cell. After being heated to drive off their inflammable contents the carbons are inserted in holes drilled in the panel just below the springs. A bell and a buzzer may be mounted



Arrangement of triple alarm circuit

on the panel, or located elsewhere if desired. One terminal of each is connected to the negative side of a battery, and the positive terminal of the battery is connected through a switch and to the flexible lead on the beam *C*.

When the solenoid has been energized the counterweight *N* is adjusted to keep both springs away from the carbons at normal voltage. Both the core and the counterweight are suspended on hooks, and it is easy to adjust the weight by adding small washers to either hook. A drop in the voltage allows the core *B* to rise and let one spring contact with carbon *D*, causing the buzzer to ring. Higher voltage causes the core to lower and the other spring to make contact and complete the circuit through the bell. The voltage at which the buzzer starts humming is determined by the adjustment of the weights on the hooks. Margin between the voltage at which the buzzer rings and that at which the bell rings is adjusted by the screw *E* on the beam.

A pair of springs below the counterweight normally do not touch each other, but at no voltage the counterweight rests on the springs, closing them and completing a separate bell and battery circuit.

To avoid using two bells sounding nearly alike, I removed the bell member from the bell on the panel and replaced it with one of a different metal. This gave a sound easily distinguishable from either the buzzer or the other bell.

JAMES E. MCCORMACK.

Haliburton, Ont., Canada.

Water Capacity of Return-Tubular and Water-Tube Boilers

MY INTEREST was attracted by the article on "Water Capacity of Boilers," by F. W. Dean, in the Feb. 4 number, in that mention was made of boilers in Cuba. I have spent most of the time since the war in Cuba, and being particularly interested in boilers have seen most of the boiler plants there. The statement is made by Mr. Dean that here there are quite a number of 120-in. boilers and some 108-in., and that a number of the latter are insured for 200-lb. working pressure.

Such boilers have never come to my notice, and I doubt that any of the standard horizontal-return-tubular type and setting have been installed here in the past fifteen years, or that any are now under steam, especially at 200-lb. pressure.

Certainly the practice in Cuba is to install the most modern and efficient boiler units possible, considering the service required, the condition of the sugar industry, and the funds available to the engineers and mill owners. And one would hardly install a 120-in. diameter return-tubular boiler with $1\frac{1}{8}$-in. shell plates, or any boiler of that type having such shell thickness exposed directly to the hot gases from the furnace.

Mr. Dean apparently recognizes the inherent defect of the return-tubular boiler for large sizes, high ratings, and high pressures. To operate such a boiler as he

mentions would require a rather expensive and continuous control over feed-water conditions, and any temporary interruption in control might result in a bagged boiler.

I have had experience with a few 108-in. boilers, more experience with 102-in. diameter boilers and still more with 96-in. diameter boilers, but none was for more than 125-lb. working pressure.

The standard 102-in. x 22-ft. boiler here has 210 to 212 tubes, and the 96-in. x 22-ft. boiler 160 to 164 tubes, the 108-in. boiler having about 232 tubes. Shells are usually about $\frac{9}{16}$ in. for the 102-in. and 96-in. boilers and $\frac{5}{8}$ in. for the 108-in. boilers.

With 55,000-lb.-tensile-strength steel and quadruple riveted butt joints, factors of safety run from $4\frac{1}{4}$ to under $4\frac{1}{2}$ in. The A.S.M.E. factor of safety is 5. These boilers can be insured at the manufacturer's safe working pressure, if required, but are generally carried at the pressure of the weakest boiler in the battery. The usual gage working pressure is from 70 to 100 lb., but in some mills where all boilers are in good condition pressures above 100 lb. are carried.

Tubes in these boilers are almost always 4 in. in diameter, and it is doubtful if smaller tubes would be satisfactory, owing to the great length and the tendency to clog up with cinders. Shell thickness is held to a minimum to avoid bagging. Considerable trouble is encountered in this connection with thick shell plates. Cane grinding is a 24-hr.-per-day operation from start to finish, and water conditions are hard to control. A shutdown for cleaning the inside of a boiler is impossible unless spare units are available to carry the load while the cleaning is being done.

I do not believe these large return-tubular boilers are generally operated much above their ratings, but I have not seen any equipped with flow meters. Water-tube boilers in many cases run continuously about 150 to 160 per cent and at pressures around 140 lb. when not connected with return-tubular boilers. Water-tube pressures in some mills are higher than this.

With two exceptions, all new mills built in Cuba since 1921 have been equipped with water-tube boilers designed for not less than 160-lb. working pressure. And the practice now in most cases, even when a plant is all return-tubular boilers, is to use water-tube boilers for replacements and additional units. This custom is gradually eliminating the return-tubular boiler from the sugar mills.

Getting back to water storage in boilers, I do not agree, in full, that the water content of the average water-tube boiler and the average horizontal-return-tubular boiler is the same per square foot of heating surface. I have at various times had occasion to figure these values as applied to boilers in Cuba.

Comparison of accepted average tube layouts shows water content per square foot of heating surface to be of the order of approximately 6 lb. for a cross-drum water-tube, 7 lb. for a long-drum water-tube, and 8 to 9 lb. for the return-tubular type. These figures are for sizes of around 8,000 sq.ft. of heating surface for the water-tube and 4,200 to 5,300 sq.ft. for the return-tubular type.

I have not had occasion to make these figures for the three-drum and four-drum curved-tube type of water-tube boiler using small tubes, but it is probable that the weight of the water per square foot of heating surface is considerably under the same figure for the standard return-tubular boiler. Probably by filling up a return-tubular boiler with small tubes approximately the same values can be obtained as with the long-drum water-tube boiler with a shallow tube bank. This would, however, remove the principal advantage held out for the return-tubular type, where large heat storage is thought necessary. Aside from first cost, storage capacity would be the only consideration in the preference of the return-tubular type over the water-tube.

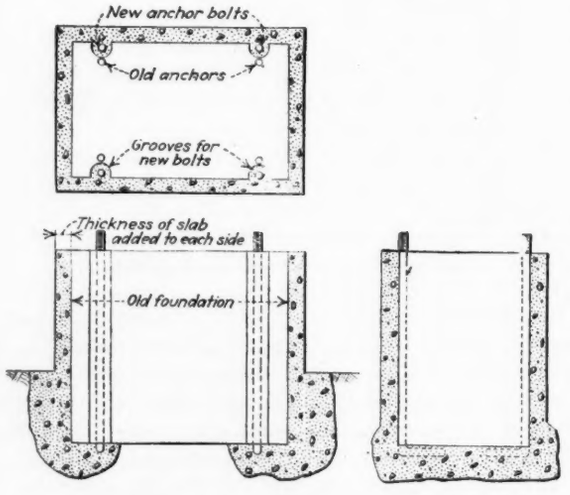
The 4,200- and 5,300-sq.ft. return-tubular boilers previously referred to are nominally rated here at 10,500 and 12,000 lb. of steam per hour, respectively, instead of the standard rating of 12,600 and 15,900 lb., respectively. On the basis of this rating, the great difference in weight of water per square foot of heating surface between the return-tubular and the water-tube is apparent. For this reason, some engineers express a preference for the return-tubular type, as it is contended sudden demands for steam for process can be more easily handled. This condition may obtain in small mills having not over 25,000 sq.ft. of boiler surface installed, but in larger mills, some of which have up to 120,000 and 150,000 sq.ft. of boiler surface installed, such demands, while possibly increasing in frequency, represent so small a proportion of the heat contained in the battery of boilers that they cause no serious drop in pressure.

Personally, I am interested in the installation of both the return-tubular and the water-tube types. Each has its own field of service. But I do not believe it economically possible for the return-tubular ever to encroach on the field of the water-tube. Otherwise the water-tube boiler would not have been brought up to the point to which it has now been developed. The prime consideration for the return-tubular is usually first cost.

Havana, Cuba. W. W. Boyd.

How an Old Foundation Was Enlarged

SOME TIME AGO we were obliged to install a new air compressor without sufficient time to build a new foundation of the required size. As it was imperative that we get the new machine running in as



Detail of changes made to the foundation

short a time as possible, it was decided to use an existing foundation block and enlarge it to the proper size by adding concrete to each side. The foundation bolts could not be used and new ones had to be substituted. The old bolts were first cut off flush with the top of the old pad with an oxy-acetylene torch. Then grooves were cut in the concrete on two sides of the foundation at the bolt locations for the new machine. The grooves were cut down to the bottom of the pad, and four loop bolts threaded on the top end were placed in the grooves and held in place at the top by wooden templates corresponding to the new machine.

A form was then built around the pad to the required baseplate size. Before doing that, however, the old foundation was cleaned of all oily marks and well roughened up to insure a good bond with new grout.

The form being set, space between it and the old pad was filled with a grout of quick-setting cement. Care was taken that the end excavation made to introduce the loop bolts was well filled with grout, so that it spread out and made a firm anchorage for the bolts.

Although this might not be recommended for a new installation, where time had to be considered it was a quick way, in an emergency, of getting the new compressor into service. M. C. COCKSHOTT.

Long Beach, Calif.

Worth-While Savings Possible in the Smaller Plants

MOST LARGE plants, with their engineers, efficiency men, research departments, etc., have learned to conserve their fluids, such as steam, air, water, etc. They realize that such mediums readily disappear unseen into the atmosphere or into wasteful processes without apparently being missed. When these small leaks and losses are totaled their cost may be surprising. Large establishments are always on the alert to recover waste steam and air, as, ultimately, economy in these fluids may save the purchase of additional equipment for excessive requirements.

It is the smaller plants that usually suffer the greatest relative losses. The investment required to produce savings and avoid waste seems prohibitive, and losses appear hardly worth the expenditure.

Some time ago one plant with which I am familiar had occasion to move into new quarters, with the purchase of more equipment. Previously they had a 300-sq.ft. vertical-tubular boiler, hand-fired, without automatic controls or feed-water regulation. It was used for pumps and steam hammers and was in a small outside building, with steam lines running to the plant.

The new building was large enough to permit the installation of a new horizontal-tubular boiler inside the structure. This led to consideration of further economies, until the final arrangement became a modern automatic boiler plant that was almost self-supporting, even though the new boiler was but a 500-sq.ft. unit.

First, the new boiler was thoroughly insulated and fitted with automatic feed-water regulators and an automatically controlled stoker with forced draft. The exhaust steam from the steam hammers and pumps was returned to a feed-water heater into which proper conditioning materials were added.

The remarkable thing is that all of this automatic auxiliary equipment was applied to a 500-sq.ft. boiler, an unusually small unit. It would not be worthy of mention in a large boiler house.

The steam saving throughout this system, its returns from building heating, and its ability to utilize low-grade coal, with practically no labor charges, showed the farsightedness of the installation. It is an answer to the question, "Does the investment pay?" F. M. AHR.

Pittsburgh, Pa.

Formula for Calculating Heat Loss in B.t.u. Per Pound of Dry Flue Gas

WITH REFERENCE to the letter of H. S. Ender in the Jan. 21 number, discussing certain values in the formula for calculating the sensible heat in dry flue gas, I cannot agree with him on his method of finding the weight of flue gas per pound of fuel burned. He assumes 50 per cent excess air in his problem. We may as well assume a certain loss and call the problem solved. The proper way to find the weight of flue gas per unit of time or per pound of fuel burned is to analyze the flue gas and eliminate the guesswork. A simple formula for finding the weight of flue gases per pound of dry coal and one that the new engineer as well as the old engineer understands is given under Formula 1.

$$W = \frac{11 \times CO_2 + 8 \times O_2 + 7 \times (CO + N)}{3(CO_2 + CO)} \times C \quad (1)$$

in which CO_2, O_2, CO, and N_2 are the per cents by volume of these gases in the flue gas as found by analysis and C equals the weight of carbon in 1 lb. of coal as found by ultimate analysis. All percentages are to be expressed decimally. The weight of flue gas having been found, the loss can be found by Formula 2, which is the same as Mr. Ender submitted.

$$L = 0.24\,W[T - t]$$

where

L = Heat loss per pound of dry coal in B.t.u.
0.24 = Specific heat of flue gas.
T = Temperature of flue gases where they leave the heating surface.
t = Temperature of air entering fuel bed.

Assume a flue gas analysis of the following values: CO_2 = 14 per cent, O_2 = 4 per cent, CO = 0.2 per cent, N = 81.8 per cent, and C = 78 per cent.

What is the weight of gas per pound of dry coal (using Formula 1)?

$$W = \frac{11 \times 0.14 + 8 \times 0.04 + 7 \times 0.002 + 0.818}{3 \times 0.14 + 0.002} \times 0.78 = 13.92 \text{ lb.}$$

If, in this same case, the weight of gas = 13.92 lb. per pound of dry coal, the temperature of the gas at the last pass = 500 deg. F. The air entering the fuel bed = 80 deg. F. What is the loss per pound of dry coal (applying Formula 2)?

$$L = 0.24 \times 13.92 \times (500 - 80) = 1{,}403 \text{ B.t.u. per lb.}$$

We can safely assume that any power plant that cannot get hold of an Orsat to analyze its flue gas is not worrying about how much heat goes up the stack.

Des Moines, Iowa. HARRY STUART.

From Among Readers' Problems

Conducted by
L. H. MORRISON

RAISING ENGINE BACK PRESSURE TO GIVE PROCESS STEAM — *Which is the most economical: To use live steam for process work or raise the back pressure to 50 lb. on the engine? We have a 20- x 36-in. corliss engine, speed 125 r.p.m. using saturated steam at 150 lb. and generating 350 kw. The back pressure is 3 lb. There is sufficient exhaust to heat the feed water and the surplus is exhausted to the atmosphere.*

Our process work requires steam at 50 lb. and is about one-third of the amount exhausted to the atmosphere by the engine. Would it be economical to operate the engine at 50 lb. back pressure to supply the process steam? The engine builders claim the engine will carry 350 kw. with 50 lb. back pressure and 170 lb. at the throttle. J. F.

If the engine is in good mechanical condition, you should use about 40 lb. of steam per kilowatt-hour, or 14,000 lb. per hour with the load you carry, namely 350 kilowatts.

If the back pressure is raised to 50 lb. and the initial pressure to 170 lb., the engine will cut off at approximately $\frac{7}{16}$ stroke. The new steam rate will be about 66 lb., so a total of 23,000 lb. will pass through the engine.

You say that at present the processes use steam equal to about one-third that now used by the engine. On this statement, the process requires 4,600 lb., or you are now using a total of 4,600 + 14,000 = 18,600 lb. With the engine exhausting at 50 lb., the total steam would be 23,000 lb., so there would be a loss of 23,000-18,600 lb., which, of course, indicates the plan is not economical unless more steam is needed by the processing.

BOILING OF WATER—*We are taught that water at atmospheric pressure boils at 212 deg. F. But I have seen wet roofs steam when I am sure the roof was at a lower temperature.* H. O.

It is a fact when water boils at 212 deg. F. the pressure of the vapor is 14.7 lb. abs., equal to the pressure of the atmosphere. But at all temperatures water gives off water vapor, or steam, which exerts a pressure of a definite value for each temperature, regardless of the other pressure that might be exerted by the atmosphere or by any other gas confined in a vessel with the water.

TONNAGE OF AN ICE MACHINE—*How can one figure the tonnage of a 10- x 10-in. single-acting single-cylinder compressor, running at 285 r.p.m., with a head pressure of 180 lb. and a back pressure of 5 lb. gage.* S. A.

The tonnage depends upon the weight of ammonia circulated, and this depends upon the volume of gas handled by the compressor. With a head pressure of 180 lb. gage, the heat in the liquid ammonia in the receiver is 149.4 B.t.u. per pound. After evaporation into dry, saturated vapor at 5 lb. gage, each pound contains 606.4 B.t.u. and has a volume of 13.29 cu.ft. Obviously 606.4—149.4=457 B.t.u. is absorbed in the refrigerating coils, and this is the refrigerating duty. As a ton is equal to 200 B.t.u., the circulation of 200/457 lb. or the handling of $200/457 \times 13.29 = 5.8$ cu.ft. of gas needed per minute to equal one ton of refrigeration.

The 10- x 10-in. cylinder has a piston displacement of 129.5. This is found from the formula

$$PD = 0.7854 \times D^2 \times S \times N$$

Where PD = Piston displacement in. cu.ft.
D = Piston diameter, sq.ft.
S = Piston stroke, ft.
N = R.p.m.

Due to re-expansion of the clearance gas, only 80 to 85 per cent of the piston displacement is actually filled with suction gas, or almost 110 cubic feet.

The tonnage is $110 \div 5.8 = 18.9$ tons.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WE HAVE three two-wire direct-current compound-wound steam-engine-driven generators that are connected for parallel operation on a three-wire system. The three two-wire generators are rated 600, 400 and 200 kw., respectively. Recently the 600-kw. machine has developed a tendency to hog the load from the 400-kw. unit. What might be the cause?

THERE are two likely causes of the trouble. The engine governor of the 400-kw. set may be sluggish in operation as a result of wear, and the engine may tend to slow down with increase in load. This can easily be checked and corrected.

Some change may have been made to the series-field windings of one machine. If shunts are used in parallel with the coils, to adjust the characteristic curves of the machines, it is possible that the shunt on the 600-kw. machine has become disconnected or broken. This would result in that machine's voltage increasing with load faster than that of the 400 kw. unit, thereby causing the large generator to hog the load.

There is a possibility that one or more of the series field coils on the 400-kw. set are wholly or partially short circuited, but this would probably be apparent from poor commutation or failure to run in parallel with the other unit.

C. E. OLIVE,
Chief Engineer,
Canadian Celanese Limited.
Drummondville, Que.

UNDER-COMPOUNDED generators may be readily operated in parallel and the load shifted as desired by adjusting either or both the shunt-field rheostats and the speed governors of the prime movers.

However, it is probable that the generators are over-compounded, in which case it is necessary to use an equalizer. The equalizer should not include the commutating field coils. For proper division of the load, the series fields and respective equalizer leads should each have a resistance inversely proportional to the rated currents of the machines.

It may be that the two machines have a separate equalizing switch that has not been closed recently, or the field rheostat contacts of the machine not

giving proper output may have become loose or dirty.

A suggested procedure is: Measure the speed of each generator at no-load and full-load, to make sure that it operates at rated speed. If one unit's speed regulation is faulty it should be corrected by adjusting the governing device of the steam engine.

Next make a load test on each unit, plotting volts against the per cent rated load in amperes. The two curves should be practically identical. If they are not, corrections can be made by adjusting the governor and shunt-field rheostat.

If no trouble is found in the governors, ammeter readings should be taken in the equalizer circuit at a time when the generators are in parallel and fairly well loaded. The algebraic difference between each generator ammeter reading and the equalizer ammeter will show the amount of current in each series-field winding. The ratio of the series-field currents should equal the ratio of the generator ratings. If this is not so, all connections should be checked and the resistances of the series-field leads changed until the current is properly divided.

The trouble might also be found in the steam engine or steam lines, but as such will be indicated when taking the speed readings. R. JOHNSON.

Crowheart, Wyo.

THE INFORMATION supplied would indicate that the tendency of the 600-kw. machine to hog the load is caused by a loose connection in the equalizer circuit or in one of the series coils of the 400-kw. machine; a short between two turns of the series coils; or the resistance between the series coils and the busbars of that machine has increased. The resistance between the busbars and the series coils of the 600-kw. machine may have decreased.

Troy, N. Y. JOHN E. STATER.

WHEN originally dividing the load between two generators, the shunt across the series fields is adjusted to obtain equal voltage on both machines. Where machines have operated satisfactorily and then give trouble, the series field winding may have become short circuited. If this is the case the short would be in the series-field winding of the 400-kw. generator. The fault may not show up until the machine reaches its operating temperature. I do not believe the trouble is in the prime movers or in the balancer set.

Denver, Colo. CARL W. WAGNER.

I SUGGEST testing the 400-kw. generator for weak field coils. Also check the connections on the generator and the switchboard. In one experience of this kind the trouble was caused by the governor, of the shaft type, being sluggish and not acting quickly enough when the load increased. After taking the governor apart, cleaning and properly adjusting it, the generator took its share of the load. JOHN L. WHITE.

Lima, Ohio.

WHEN two compound generators are operating in parallel either of them may be made to take care of more load by increasing its voltage. The voltage may be increased by increasing the field strength or the speed, the latter being controlled by the engine governor. As the machines have operated satisfactorily in the past and only recently one machine developed a tendency to take more than its share of the load, it would appear that the governor on one unit is not functioning satisfactorily.

I suggest checking the belt tension and spring pressure and other parts on the governor. Apparently the trouble is not in the generators, since they are giving no trouble except at heavy loads. It is assumed, however, that the cables leading from the machine are of the proper size, and also that the equalizer bus is properly closed and not grounded.

Pittsburgh, Pa. NOBLE WATKINS.

ASSUMING that no changes have been made in the wiring, the first thing to check is the speed variation of the machines. The per cent of speed variation must be practically alike for all machines operating in parallel.

If the speed variation is not at fault then the brushes might have been shifted, perhaps to eliminate sparking, thereby changing the compounding of the machines. If the field of the 400-kw. machine was weakened in this way it would allow the 600-kw. unit to take more than its share of the load.

Although the machines have been operating satisfactorily in parallel for some time, it might be necessary, due to changed load conditions which demand closer compounding or changes in the air gap because of bearing wear, to check the compounding.

I remember a similar condition that was caused by the rheostat arm dropping. The arm was heavy and there was a little slippage between the operating wheel and shaft, which allowed the arm to fall one button, causing the voltage and load to be reduced. Repairing the rheostat and increasing the pressure of the arm on the buttons eliminated the trouble.

Baldwin, N. Y. S. B. CONKLIN.

A Question for Our Readers

THERE were objections to starting early types of squirrel-cage motors on full voltage, because of the heavy inrush current, the danger of distorting the stator windings and the possible damage to the driven machine. I understand that modern designs have largely eliminated these objections. Will some of POWER's *readers tell me of their experiences starting squirrel-cage motors on full-voltage, in sizes of 30 hp. and above?* F. A.

Suitable answers from readers will be paid for and published in the April 15 number.

THE trouble may be in either the steam or the electric equipment, or it may be a combination of the two. If on the steam side, it is possible that the governor of the small machine is sluggish and allows the engine to slow down as the load increases. The remedy is to overhaul the governor.

The fact that the larger machine is showing a tendency to hog the load arouses the suspicion that there is something wrong in the equalizer circuit that has had the effect of increasing the resistance in the series coils of the small machine. I would advise looking for loose or dirty connections. Possibly when connecting up after overhauling, someone may have put an iron washer under a connection lug.

HOWARD LIVINGSTON.

Los Angeles, Calif.

SINCE the neutral wire is taken from a balancer set, this connection cannot have any bearing on the trouble. First check the speed regulation of the two machines to determine if the engine governors are functioning properly. If they are, the trouble may be caused by poor connections in the 400-kw. machine's series-field winding or in its cables leading to the busbars. Carbon or copper dust on the shunt across the series field of this machine may have caused the load shift.

Poor connections at the terminals of the shunt across the 600-kw. machine's series-field winding could produce the trouble. R. F. BENNET,
Crystal Tissue Co.

Middletown, Ohio.

THE cause of the 600-kw. generator hogging the load is not a fault of that generator, but of the 400-kw. unit. If the governor does not operate properly, if one of the valves only partly opens, or if there is some obstruction in the piping (allowing only a certain amount of steam to enter the engine cylinder) the engine can carry only a limited load.

Most likely the fault is in the governor strainer, throttle valve, or header valve; or it is possible, but not probable, that the fault is in the engine valves. J. O. BISHOP, *Chief Engineer,*

Estes Park, Colo. Bear Lake Lodge.

IN ONE case of a three-phase alternating-current engine-driven generating set hogging the load from hydro-electric machines, the trouble was caused by faulty governor operation. The same may be true in this case.

Calgary, Alberta. JAMES GRANT.

Feed-Water Purification Systems

Demand Expert Control

Mr. Powell has played a leading part in the movement to apply scientific methods to the purification of boiler feed water. This article—abstract of a paper presented last year before the American Gas Association—shows definitely the dollars and cents value of competent control of feed-water purification.

By S. T. POWELL
Consulting Chemical Engineer, Baltimore, Md.

MUCH has been written concerning methods of feed-water analysis, but little information is available to indicate the specific importance of such data in the control of steam stations, and little has been published concerning the economic value of such control. It is largely for this reason that many companies have not been impressed with the necessity or the value of this work. The saving resulting from accurate control of the feed-water system by routine chemical analyses can easily be demonstrated, and plants where accurate cost records have been kept can verify these statements.

No single method of feed-water treatment is applicable to all plants; each should be designed and operated with specific reference to the local conditions. Since there is no universal treatment, there can be no universal method of control. Tests to be made of the treated feed water and concentrated boiler water must depend upon the conditioning system employed. For this reason it is difficult to prescribe a set of tests that will meet all requirements. There are, however, certain routine tests which are of value and from which efficient control may be obtained. Those which in most cases will be of value are listed in the accompanying table.

The majority of the tests indicated in the table require no detailed instructions, since the technique may be found in any standard analytical text on water analysis. This does not apply to the determination of sulphates, phosphates and specific gravity, for which new rapid methods have been developed.

The standard gravimetric method of determining sulphates is not applicable to routine work in finding the sulphate content of concentrated boiler water, principally because the method is time-consuming and the accuracy afforded is not ordinarily required for plant control.

The Parr turbidimeter method is sufficiently accurate for determining the sulphates in boiler waters, and it has the added advantage of being fairly rapid and requiring no special technique. It consists of measuring the turbidity produced by precipitating the sulphates by means of barium chloride in a slightly acidified solution. The finely divided barium precipitate is measured by limiting the depth of solution through which a standard light can be detected. The apparatus is standardized against solutions of sulphates of known strength.

The carbonate and hydrate alkalinity of concentrated boiler waters can be found by the ordinary titrimetric method. The method is reliable, however, only in the absence of appreciable amounts of organic matter when the water is relatively clear. When concentrated boiler waters contain an appreciable amount of organic matter in solution or suspension, or where the water is turbid or highly colored, these determinations should be made by the Winkler method.[1]

A highly sensitive hydrometer has recently been put on the market which is being used extensively for rapid analyses of concentrated boiler water. In addition to indicating the specific gravity of the water, the total solids and sodium sulphate content can be determined. This is accomplished by simple calculation from the specific gravity, alkalinity and the chlorides previously determined.

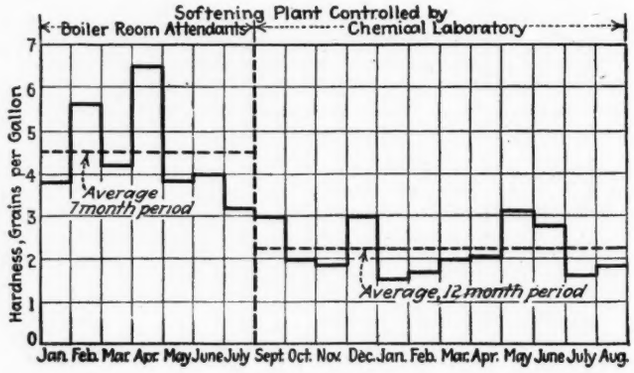


Fig. 2 — Improvement in the quality of boiler-feed water (as measured by the residual hardness in the softened water) resulting from placing the operation of the system under the control of the chemical laboratory

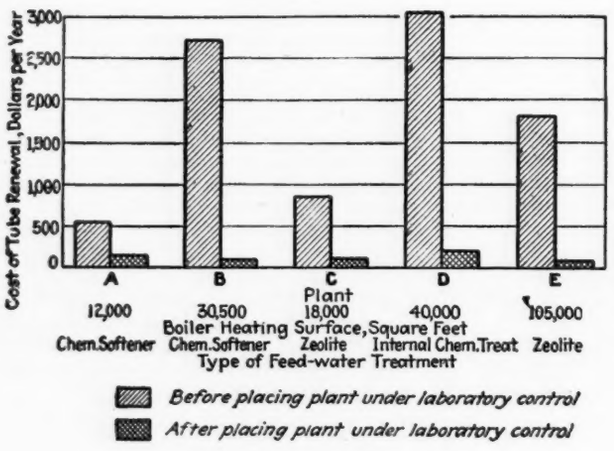


Fig. 1 — Reduction in boiler tube renewals for one year, at five plants, resulting from routine control by chemical laboratory

Conditioning feed water by phosphates is now practiced widely, since such treatment has certain specific value. The use of phosphates under some conditions inhibits the formation of hard scale and is of value in preventing embrittlement of boiler steel. Comparative tests of the various methods have indicated that for ease in manipulation and reliability the method of phosphate determination recommended by Straub[1], is most satisfactory.

It is difficult to generalize in reference to the specific cost of chemical analyses of feed-water treatment systems. In the majority of plants, however, the cost of

[1]Described in detail in the original paper.

laboratory control of boiler-water conditioning can be fully justified by the resulting improvement in operation. As an illustration the results obtained at a number of stations are given in the accompanying charts.

Attention is directed first to the reduction in the cost of tube renewals in the five plants before and after the feed-water conditioning was controlled by routine analyses. In each the water was treated by an approved system. In every case there was a marked saving in tube renewals immediately after accurate chemical control was inaugurated. Prior to placing the plants under the chemical laboratory, the systems were operated by the watch engineers or firemen. Some determinations were made of the feed water, but there was no certainty of the accuracy of the analyses and there existed a complete lack of intelligent interpretation. Directly after accurate chemical control was inaugurated, a marked improvement was noted, as indicated in Fig. 1.

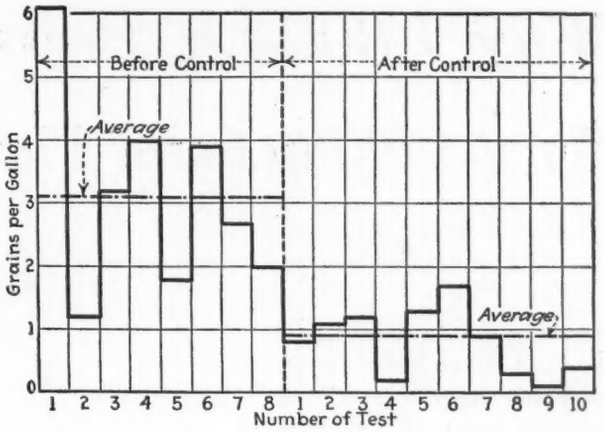


Fig. 4 — Reduction in priming and foaming of boilers due to controlling boiler blowdown by routine chemical analyses of the concentrated boiler water as measured by total solids in condensed steam

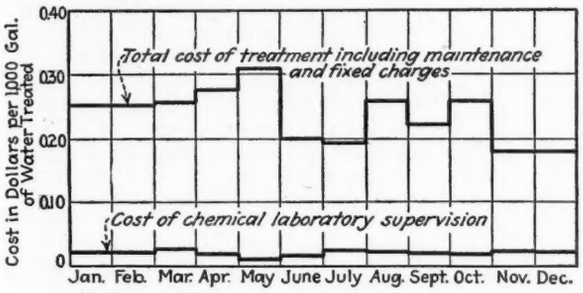

Total cost of treatment including maintenance and fixed charges
Cost of chemical laboratory supervision
Cost in Dollars per 1,000 Gal. of Water Treated
0.40
0.30
0.20
0.10
0
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Fig. 3—Cost of control of feed-water softening by chemical laboratory supervision in comparison with total cost of operation (chemical softener-capacity = 650,000 gal. daily)

Frequently a gross waste of chemicals in the operation of water-softening plants results from failure to regulate the chemical reagents required to soften the waters. The hardness of many surface waters fluctuates greatly and requires frequent adjustment of the chemicals employed. Such adjustments can only be made intelligently by analyses of the untreated and treated water. More important still is the interpretation of the analytical data, which should be made by a trained chemist. Justification of the cost of laboratory control is clearly apparent in many installations.

Rarely is a water-softening plant operated continuously at maximum efficiency if the control is left to the boiler room force, without supervision by the laboratory. A typical instance of the possible improvement that can be effected by control of the system by trained workers is illustrated in results of such control shown in Fig. 2.

A cost analysis of chemical control of feed-water systems to allocate the specific value of such control is difficult and influenced by many local factors. Cost data, therefore, may be misleading unless interpreted with respect to the specific set of conditions.

In Fig. 3. is reported the cost of laboratory control in comparison with the total cost of treatment. In this instance, the plant is under control of a chemical engineer and two assistant analysts whose duties are confined exclusively to control of the boiler feed water, combustion and other problems peculiar to a modern steam station. The figures demonstrate clearly that the cost of chemical control is fully warranted, taking into consideration the cost of this control in comparison with maintenance.

ROUTINE TESTS FOR THE CONTROL OF BOILER FEED WATER AND CONCENTRATED BOILER WATERS

Raw Water	Treated Water	Concentrated Boiler Water
Temperature	Temperature	Temperature
Total solids	Total solids	Total solids
Suspended solids	Suspended solids	Suspended solids
Total alkalinity, carbonate, bicarbonate and hydrate alkalinity	Total alkalinity, carbonate, bicarbonate and hydrate alkalinity	Total alkalinity, carbonate, bicarbonate and hydrate alkalinity
Chlorides	Chlorides	Chlorides
Sulphates	Sulphates	Sulphates
Free CO_2	Free CO_2	Free CO_2
Hydrogen-ion concentration	Dissolved Oxygen	Phosphates
	Hydrogen-ion concentration	Specific gravity
		Hydrogen-ion concentration

Priming and foaming of boiler water is influenced by a number of factors and constitutes a perplexing problem in the operation of steam boilers. Much can be done to regulate carryover of water from boilers by control of the concentration of solids in boiler water. This can be accomplished most satisfactorily by regulating the blowdown cycle by analyses of the water at regular intervals. A recent investigation of priming and foaming boilers clearly demonstrated the value of this method of control. The improvement of the quality of the steam is indicated in Fig. 4.

It is impossible to allocate the saving in general operation and maintenance resulting from the dry steam, but that a marked saving results cannot be questioned.

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"Heavy losses have been sustained during the past two years in some of the largest industries in this country from bad feed-water conditions which could have been prevented had the steam stations been under proper analytical control."

—S. T. Powell.

Avoiding Crankshaft Failures

In a paper read before the International Aeronautical Exposition, Roland Chilton states that while a crankshaft may be constructed of material having an ascertained safe fatigue-endurance stress of 40,000 lb. per square inch and it is impossible to predict any operating stress higher than 10,000 lb. per square inch, yet a failure may occur in every few hundred shafts. The failure depends entirely on how long the engine happens to be operated at a speed synchronous with the natural torsional period of the shaft system, and has absolutely no connection with calculable stresses from inertia and explosion loads. He cited the well-remembered crankshaft failures on the Graf Zeppelin as an example.

Pointing out the virtual hopelessness of making a crankshaft stiff enough to support the worst resonant stresses, he observed that when increase of crankshaft diameter eliminates breakage from those causes it is because the change in dimensions has taken the critical frequency outside the operating range. Some form of vibration dampener becomes necessary if all critical speeds are to be eliminated.

As a further example, Mr. Chilton spoke of installations in which the liability of breakage was reduced by deliberately weakening, or introducing flexibility into, some part of the transmission. Thus, a marine engine crankshaft which was inadequately strong when transmitting directly to its load proved quite satisfactory when driving a propeller through a long transmission shaft having only one-tenth of the crankshaft's own strength.

Torsional vibration in the crankshaft becomes especially important in connection with reduction gears, and creates a special need for some dampening device or spring coupling.

Why 1,800-Lb. Pressure Was Selected

For the Philip Carey Plant

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Reporting a talk given by W. E. S. Dyer before a recent meeting of the Philadelphia section of the A.S.M.E. Although many details of the engine were shown, no expected performance figures were indicated

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IN PRELIMINARY design calculations for the Philip Carey Company's new power plant it became apparent that considerable power would have to be developed from a relatively small steam flow, if all of the power were to be obtained as a byproduct of process steam. About 6,000 kw. of energy must be supplied to the factory from a steam flow of 120,000 lb. per hour. This quantity of steam is used at 45-lb. pressure in the drying rolls of paper machines, for heating asphalt, building heating, etc.

Thus the prime mover had to have a steam rate of not over 20 lb. per kilowatt. The best that was offered by American turbine manufacturers was a steam rate of 21 lb. per kilowatt, which, it is evident, did not meet the required conditions. So the search for a prime mover led to Europe and the shops of A. Borsig, Berlin.

By using steam at 800 deg., an engine having the required economy could be obtained, but the physical dimensions of the 6,000-hp. engine desired became so large as to make it impossible of construction. However, by increasing the steam pressure to 1,800 lb. dimensions were sufficiently decreased to make the engine comparatively easy to design. With these initial steam conditions, and exhausting at 60-lb. back-pressure, the steam consumption of the engine is expected to be considerably below the required 20 lb. The design is such that at 1,425-lb. minimum initial pressure the engine will develop 5,400 horsepower.

The engine consists of two single-acting high-pressure cylinders, two single-acting intermediate-pressure cylinders and one double-acting low-pressure cylinder. All of the cylinders are vertical. The single-acting high- and intermediate-pressure cylinders are in tandem, which eliminates high-pressure piston rod stuffing boxes.

The five cylinders are all cast separately. The two high-pressure cylinders are 14 in. in diameter, the intermediates are 25 in. and the low-pressure is 33 in. diameter. The stroke is 25 in., and the engine will operate at 225 revolutions per minute.

Piston-type, double-ported valves are employed, operated by double eccentrics. No valve stem packing is used, close fit and lubrication being depended upon to prevent steam leakage.

Cylinders are supported on cast steel *A* frames, and cylinders and frames are fastened to the engine base by through bolts. The crosshead bearing surfaces are not cast integral with the *A* frames, but are bolted to them. Glass doors in the frames and inside electric lights permit observation of crank and connecting rods.

Main shaft bearings are 14½ in. in diameter. The babbitt of these bearings is reinforced with steel plates to prevent it being pressed out at the ends. Oil is used for cooling the bearings and also the crosshead bearing.

Lubricating oil is furnished by two 175-g.p.m. pumps driven from the main shaft. Normally only one pump is operating, the inlet valve to the other pump being closed. Oil pressure from the pump in operation holds the inlet valve of the second pump closed, and in case the pressure drops below 16 lb. the valve is opened, putting the emergency pump in service. An auxiliary steam pump is being installed to provide lubrication while starting.

It is not expected that cylinder lubrication will be necessary. However, in case excessive wear is experienced, flake graphite will be used and subsequently recovered from the feed water.

Steam will be generated in water-tube cross-drum boilers. The drums are of forged steel 40 in. in diameter, and the walls are 5 in. thick. Before entering the low-pressure cylinders the steam is returned to reheaters, which raise the temperature to 525 deg. The boilers will be fired with pulverized coal from unit mills. Burners will be located at the four corners of the boiler and directed tangential to a small circle at the center of the furnace.

Exhaust from the engines at 60-lb. pressure will be delivered to evaporators, and the steam from them at 45 lb. will be used by the factory. Condensate from the evaporators, slightly under 310 deg., will be fed to the boilers by 3¾ in. x 24 in. triplex boiler-feed pumps. One of these will be driven by motor, the other by a compound engine.

In the discussion following the paper, J. B. Crane of Combustion Engineering Corporation gave some further details on the boiler. The furnace will be provided with water walls consisting of 3½-in. tubes with 1-in. fins. The economizer will consist of 2-in. finned tubes. The boiler is to be constructed of 0.75 carbon steel, which, Mr. Crane stated, tests have indicated has but little creep at the expected operating temperatures.

Hydro-Electric Plants Increased Capacity in 1929

THE CAPACITY on Jan. 1 of waterwheels installed in water-power plants in the United States having 100 or more horsepower was 13,807,778, a gain of 236,248 hp., or 1.7 per cent for the year, according to a report just made public by the Geological Survey, Department of the Interior. The increase in capacity of installed waterwheels during 1929 was the smallest for several years, according to the report.

There are under construction, however, water-power plants of a total capacity of about 800,000 hp. which are due to be completed this year, it was pointed out. The small increase last year should not be considered an indication of a marked change in the utilization of the country's water-power resources, it was added.

The Pacific division of the United States continued to hold the lead in developed water power which it has maintained since 1921. It gained 0.4 per cent in amount of developed water power in 1929, and at the close of the year had 24.4 per cent of the total for the country. The South Atlantic division again held second place, with 19.2 per cent of the total. California, which has led all states since 1926 in developed water power, was in front again in 1929, having 16.7 per cent of the total of the nation. New York has trailed California during the same period, and was in second place last year, with 13.1 per cent of the total for the country.

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JANUARY SALES of mechanical stokers totaled 54 with a capacity of 13,607 hp., as compared with 79 of 44,976 hp. in December and 97 of 42,392 hp. in January, 1929, according to figures just made public by the Department of Commerce.

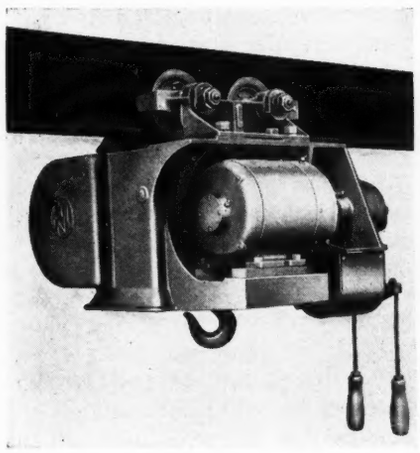
WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Electric Hoists in Capacities From $\frac{1}{8}$ to $7\frac{1}{2}$ Tons

A COMPLETE line of electric hoists in sizes from $\frac{1}{8}$ to $7\frac{1}{2}$ tons' capacity, embodying important features in design, has been introduced by the Hoist & Crane Division of Robbins & Myers, Inc., Springfield, Ohio.

A cast-steel trolley adjustable to nine sizes of I-beams carries a main frame of Aremite alloy metal, which, it is claimed, has a tensile strength of 35,000 lb., or more than double that of gray iron, with an elasticity



Hoist with adjustable trolley

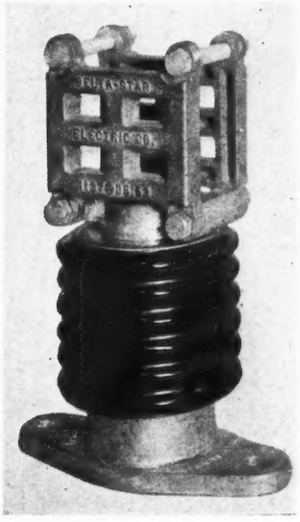
which enables it to withstand severe shocks in service. An inclosed-bottom block designed to retain the rope on the sheaves under all conditions of service has all parts shrouded so as to guide itself easily into the rope flare when swinging. Other features include gearing of alloy steel, roller bearings and an aluminum finish throughout.

The motor used on all sizes is of the totally inclosed, ball-bearing high-torque-type. The rope-operated controller, which is in a weatherproof enclosure, is fitted with a spring which automatically returns the controller to the off position when the operating rope is released.

Heavy-Duty Bus Support

A HEAVY-DUTY type of bus support of the center-bolt form is illustrated. The six-inch diameter insulator unit has, at each end, metal inserts threaded at the center for bolts by which top and bottom fittings are attached.

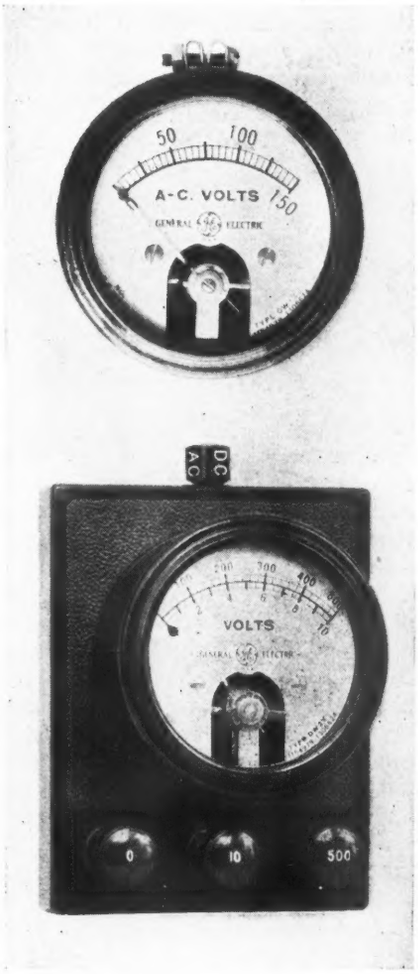
The advantage of this single-bolt construction is that the fittings can be turned to any position in a horizontal plane, permitting the bus to be run at any desired angle to the supporting structure. The support is put out by Delta-Star Electric Company, 2400 Fulton St., Chicago, Ill.



Bus support of center-bolt form

Small Instruments for Testing

SMALL VOLTMETERS and milliammeters, in $2\frac{1}{4}$ and 3-in. cases, for use on both alternating- and direct-current lines have been introduced by the General Electric Company, Schenectady, N. Y. The meters have molded compound cases and bases and are equipped with full-wave copper oxide rectifiers mounted



Panel and portable type meters

within the case. The rectifiers permit of the instruments being used on alternating-current circuits, and thus make it possible to provide alternating-current instruments in low voltage and current rating having high sensitivity. The voltmeters are available in ratings from 2 to 150 volts, and the milliammeters in ratings from 0.5 to 15 milliamperes.

A portable voltmeter with a double-range 10/500-volt scale and a knob for adjusting to read either alternating or direct current is also available.

Improved Welding Blowpipe

NEW PRINCIPLES of design have been incorporated in the type W-17 blowpipe recently announced by the Oxweld Acetylene Company, 30 East 42d St., New York. The tip and welding head are of one-piece construction, being combined in a long and slender stem of the goose-neck type. The low-pressure injector principle is employed, with improved design of injector and mixing chamber. The injector is located at the base or handle end of the stem. Each welding head has its own nut for attaching it to the handle of the blowpipe, the nut being constructed so that it extends beyond the injector when the welding head

Type W-17 blowpipe

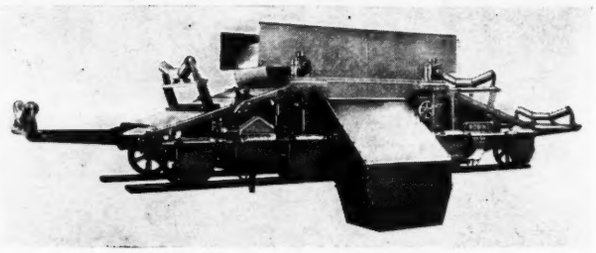
is detached to protect the injector from damage. A fine pitch thread makes it possible to tighten or loosen the nut easily without the use of a wrench.

The inner cone of the flame produced by the torch is somewhat different from that obtained heretofore. It is shorter and thicker and has a tendency to assume the shape of a ball at the end. This, it is claimed, speeds up the rate of welding, because a larger portion of the high-temperature flame (or inner cone) surface is brought closer to the metal.

New Hard-Surfacing Rod

PRODUCTION of surfaces of almost pure tungsten carbide by hard-surfacing with a welding rod is a recent development of the Stoody Company, Whittier, Calif. The rod used in the new process is known as "Borod," and consists of a mixture of unsmelted alloy materials mixed with a suitable binder and held within a soft steel sheath.

When the rod is exposed to the heat of the welding arc or gas flame, the sheath melts down and carries with it the alloy content, consisting of metallic tungsten, carbon and other materials.



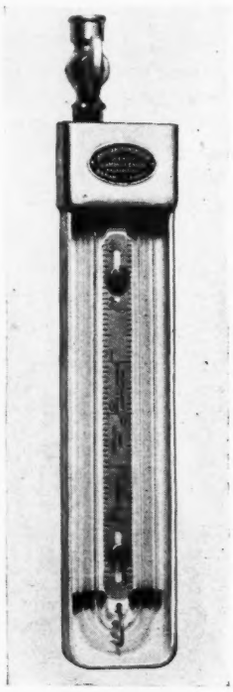
Double tripper with single drive

Double Reversible Automatic Tripper

THE accompanying illustration shows a 36-in. tripper for a belt conveyor put out by the Robbins Conveying Belt Company, 15 Park Row, New York. It is a double, reversible unit arranged to discharge from either side. It consists of two standard type S heavy duty trippers equipped with roller bearing idlers and arranged to operate from a single drive.

Manometer With Large-Bore Tube

WITH a view to overcoming the difficulty usually encountered in filling the tubes of manometers of the usual type, the Meriam Company, 1955 West 112th St., Cleveland, Ohio, has recently brought out a specially designed manometer with a



"Jumbo" type manometer

larger bore of tube than that generally employed. The larger bore not only makes it easy to fill, but also facilitates the disengagement of air-bubbles, which would affect the accuracy of the readings.

A still further advantage of the larger bore, as pointed out by the manufacturer, is that the greater area largely neutralizes the capillary action of the sides of the tube.

"Tempaloy," a Hardenable Copper Alloy

A HARDENABLE copper alloy, known as "Tempaloy," has been developed by the American Brass Company, Waterbury, Conn. The new alloy has the approximate composition of 95 per cent copper, 4 per cent nickel, and 1 per cent silicon. When heated to 750 to 800 deg. C., the nickel silicide goes into solid solution, and if chilled from this temperature the alloy is soft and ductile. When heat-treated at approximately 450 deg. C. for several hours, the nickel silicide is precipitated and the material becomes hard and strong, resembling mild steel in its physical properties.

Addition of aluminum to this alloy strengthens it considerably and accentuates the hardening properties. Tempaloy to which 5 per cent aluminum has been added has a yield point of 25,000 lb. per square inch and a tensile strength of 65,000 lb. per square inch after quenching from 800 deg. C. When heat-treated at 450 deg. C., the yield point is 100,000 lb. per square inch and the tensile strength 130,000 lb. per square inch. Addition of larger amounts of aluminum to this alloy results in a material having a tensile strength of 150,000 lb. per square inch.

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CORRECTION—In the description of the Anemo Tachometer that appeared on page 410 of the March 11 number, the name of the manufacturer was inadvertently omitted. This instrument is manufactured by O. Zernickow Company, 15 Park Row, New York City.

NEWS of the FIELD

Spot News

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EXTENSION *of the powers of the Federal Power Commission to include the regulation of rates and services of all companies producing, by steam or water power, or distributing electricity in interstate commerce, and also parent holding and management corporations, was proposed in a bill introduced in the Senate March 12 by Senator Couzens of Michigan. The bill provides for an independent body patterned along the lines of the Interstate Commerce Commission.*

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THE THAYER BILL *creating a temporary state commission to report a plan for development of the St. Lawrence River water power passed the New York State Senate on March 12 and went to the Assembly. It is expected that the bill will be signed by Governor Roosevelt this week.*

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SEEKING *to purchase the $50,000,000 New York Steam Corporation to effect economies through the interchange of steam between the large plants of both companies, the Consolidated Gas Company of New York City has applied to the Public Service Commission for approval of a new stock issue to finance the transaction.*

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A LARGE INCREASE *in power transmitted across state lines is indicated by the preliminary report of the Federal Trade Commission, which has been collecting this data for the Senate Interstate Commerce Committee. It is evident from the report that the gross interchange between states in 1929 is much larger than the 10.9 per cent estimated for 1928 by the National Electric Light Association.*

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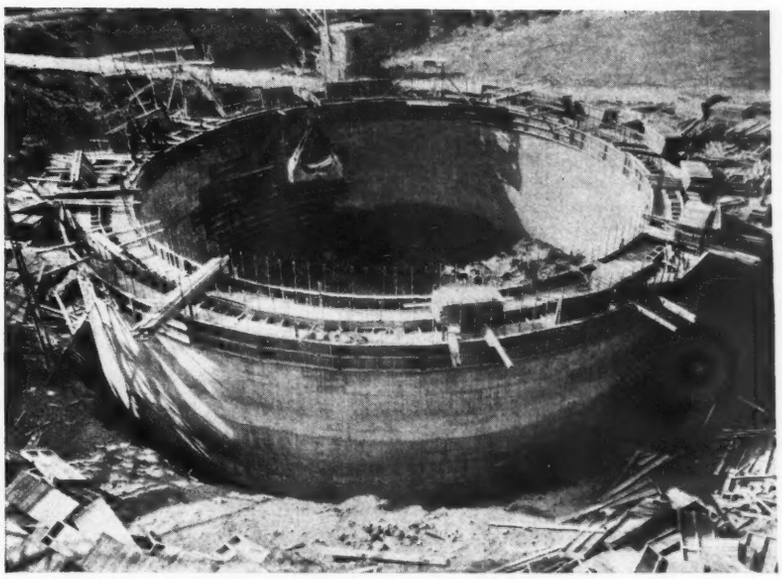
AN APPROVED TYPE *certificate of the Department of Commerce has just been issued on the Diesel aeronautical engine developed by the Packard Motor Car Company. Rated at 225 hp. at 1,900 r.p.m., the engine passed satisfactorily both flying and block tests given under the supervision of the Army Air Corps.*

World's Largest Pumping Station to Be Erected at Detroit



Construction view of storage well for Detroit pumping plant, which will be 56 ft. in diameter and 100 ft. deep

CONSTRUCTION of the largest single pumping station in the world will soon be started by the City of Detroit, Mich., to meet that city's increasing demand for water. The new project, known as the Springwells Station, is expected to be in operation in 1932.

All of the pumping equipment in the new station will be of the most modern design, and will be driven by electric motors built by General Electric Company. The centrifugal pumps that take water from the large well are low-lift, all being manufacturer by the Worthington Pump & Machinery Corporation. Six will be 750-hp. units, and two will be 350-hp. in rating. The 750-hp. pumps will be driven by synchronous motors, while the smaller pumps will be driven by slip-ring induction motors.

The horizontal centrifugal pumps that take the water from the filter plant and pump it into the mains are high-lift, and these will also be made by Worthington. Sixteen of them will eventually be installed. Twelve are now being made. Four will be rated at 1,725 hp. each, and will be driven by synchronous motors running at 600 r.p.m.; two will be 1,675-hp. driven by synchronous motors at 514 r.p.m.; and two will be 1,425-hp. driven by sychronous motors at 514 r.p.m. The four remaining pumps will be driven by slip-ring, variable-speed induction motors, two rated at 1,400 hp., 713 to 647 r.p.m., and two rated at 1,200 hp., 507 to 461 revolutions per minute.

The great size of the new pumping station and the consequent large demand for electric energy made it necessary to plan a special power plant for the Springwells project. This is designed for an ultimate capacity of 30,000 kw., consisting of two 5,000-kw. and two 7,500-kw. turbine-generators, and using a 5,000-kw. transformer bank. Auxiliary power in the station will be furnished by three turbine-generators each rated at 500 kw. Steam will be extracted from the stages of the turbines and used for heating the building.

The land tunnel for the new project is nearly complete. The river tunnel to connect the land tunnel with the new intake is under construction. Ventilation of this tunnel during construction, a matter of great importance because of pockets of hydrogen sulphide gas which occur in the limestone rock formations, is provided by two centrifugal compressors, each supplying 9,000 cu.ft. of air per minute at a pressure of 2 lb. and driven by 120-hp. induction motors. Specially designed control and indicating equipment shows the delivery of air from the blowers.

100 Years Ago Thaddeus Fairbanks Invented the Platform Scale

FROM THE multitude of special weighing machines now in use to the steelyard of ancient times is a far cry. There has been no improvement in methods of weighing until the dawn of the machine era, when in 1830, Thaddeus Fairbanks invented the platform scale, from which all modern scales are direct descendants. The present year marks the hundredth anniversary of this important event and is being featured as the Fairbanks Scales Centennial.

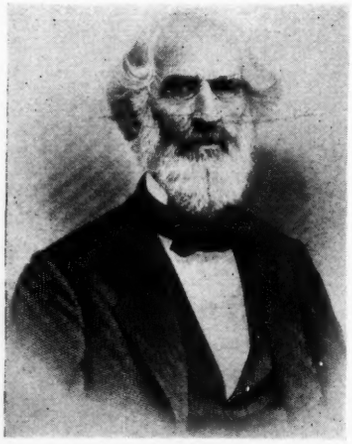
It was in 1815 that Major Joseph Fairbanks moved from Brimfield, Mass., to St. Johnsbury, Vt., and set up grist and saw mills on the banks of a little creek that ran through this old Vermont town. His sons, Erastus and Thaddeus, had even broader visions, for they established a wheelwright and foundry business and proceeded to manufacture saws, pitchforks, cast-iron plows and stoves.

About 1830 the "hemp craze," as it was called, struck Vermont and the farmers expected to make substantial fortunes in raising hemp instead of corn. Contracts for making hemp-dressing machines were awarded to the Fairbanks brothers.

THE QUESTION now arose — How was the hemp to be weighed? The old steelyard was of little use for this service, and so Thaddeus conceived the idea of constructing a huge steelyard beam suspended from a high frame with chains to grapple the axle of the cart. An approximate weight was thereby obtained by a slow and laborious process. Thaddeus studied the problem and finally conceived the idea of supporting the platform upon an A-shaped lever with the tip of the lever connected to the steelyard by a rod.

Although unaware of it at the time, Thaddeus had revolutionized all weighing methods, and at that moment the steelyard of old Rome took its departure. From this small beginning, the platform scale in all of its ramifications was developed. Today the same principle is in use, whether in a health scale, a laundry scale or the ponderous track scales used for weighing the largest railway locomotives. Typically American and with all the ingenuity that is traditionally associated with the New England Yankee, Thaddeus Fairbanks set out on an undertaking that has carried his name, and the idea for which it stands, into the remotest corners of the earth.

In 1913-14 the plate fulcrum principle in scale construction was applied to railway track scales. This idea had been developed in 1875 and was then patented for use on large capacity scales; it was first used by the inventor, A. H. Emery, in that year on steel testing machines built for the Bureau of Standards. The principle was given considerable study by Fairbanks engineers with the result that it was finally adopted for the track scale installations.



Thaddeus Fairbanks

Self-indicating or dial machines have been the most recent development in scale making, and Fairbanks St. Johnsbury factory now makes them in capacities from 50 to 40,000 lb. Leonardo da Vinci is credited with inventing these scales. Drawings of them in his notebooks have been preserved.

The world's largest scale was built recently at the St. Johnsbury factory and is located at the plant of the Hamilton Furnace Company at Hamilton, Ohio. The Hamilton foundry has installed a movable mixer built on railroad trucks. A Fairbanks scale weighs the entire load, the car and its contents. The loaded mixer weighs a million pounds, six times the weight of a loaded coal car. The new scale is an exact duplicate of other scales except for its large proportions, being a regular Fairbanks two-section railroad track scale. Though simple in construction, its accuracy is guaranteed to within 20 lb., or 0.002 per cent of full scale.

Enlarge Australian Power and Briquette Plants

The Victorian (Australia) Electricity Commission's big plant at Yallourn on the Morwell brown coal field, 84 miles from Melbourne, is being extended to double the present output of electric power and of briquettes. The present capacity of the generating station, which is the largest in Victoria, is 75,000 kw., and now there is being added a second plant of 75,000 kw., with three generators rated at 25,000 kw. each. Total cost of the extensions is estimated at $14,030,000.

The work of adding to the plant has been in progress for some time. The Richmond terminal station is in course of construction; test sections of the second transmission line have been erected on portions of the route, and sections of the new power house are ready for the delivery of the first machines. The first of the new generators will be ready for operation in March, 1931, and the others will follow until the maximum capacity is installed in readiness for the demand in 1935. After this, further extensions of the supply will have to be designed. Contracts already let include one of $741,875 for two turbine-generators and one of $635,190 for eight boilers.

Capacity of all the commission's undertakings, including the hydro-electric plant of the Sugarloaf-Rubicon system, is now 102,500 kw., and last year's maximum demand of 92,000 kw. is expected to increase to 100,000 kw. this year and to 119,000 kw. in 1931. By 1935 the demand is expected to reach 160,000 kw.

The briquette factory, associated with the Yallourn works, has reached its maximum output, maintaining an average of 470 tons a day. Extensions in course of construction will increase the capacity to 1,200 tons per day. Much of the plant for the extensions has already been delivered and contracts for the whole of the work have been let. It is expected that the extended plant will be ready for operation in September, but arrangements are being made for the operation of a portion of the new plant before that date to increase the production to 600 tons per day.

Both power and briquetting extensions will require a largely increased supply of brown coal from the open cut, which will be excavated all over to a depth of 200 ft. with the new deep coal dredge which has arrived from Germany. This machine, working in conjunction with the present dredge of similar design on the upper levels of the cut, will be capable of providing 10,000 tons per day, which the undertaking will use when completed.

U. S. Chamber Issues Report on Muscle Shoals

A report seeking to establish a "groundwork of facts" regarding Muscle Shoals has been prepared by the Water Power Policies Committee of the United States Chamber of Commerce after a year's deliberation on general power matters. This report contains no recommendations. These are expected to follow after a final session early in April. It can be guessed from the Chamber's well known opposition to government ownership and subsidy of private interests that the final report will not favor government action by apparent subsidy through power or otherwise which would tend to give special privileges to a successful bidder for operation of any Shoals properties. Some cost figures are included in the factual data which tend to show that profitable fertilizer production at Muscle Shoals would be difficult. A map is included which shows the nearness of several Southern cities, the inference being that power tie-ins would be readily practicable.

Philippine Islands to Have 30,000-Hp. Hydro Plant

A 30,000-hp. hydro-electric power development project is under construction by the Manila Electric Railway & Light Company of Manila, P. I., which is erecting a 90-ft. dam of the arch gravity type above the famous Botocan Falls on the island of Luzon, making available a 610-ft. head. The flow of the river varies between wide limits in true tropical fashion, but a low minimum has been assumed which, it is already apparent, is far below the actual flow at any time. The average is probably in the neighborhood of 2,000 sec.-ft.

Satisfactory progress is being made on a 4,000-ft. tunnel, from 25 to 30 ft. per day being driven from each heading, and it is now more than one-third complete. A 5,000-ft. conduit will convey the water to the power house, where the installation will consist of two vertical turbines and an impulse wheel. Power will be carried to Manila over a 110-kv. transmission line. It is expected that the dam will be completed by June of this year and the entire project by the end of 1930. Construction work is in charge of J. G. White Engineering Corporation, with headquarters in New York.

Hydraulic Laboratory Bill Soon Before House

After having been endorsed by General Lytle Brown, chief of army engineers, the hydraulic laboratory bill has been reported out of the House Rivers and Harbors Committee and will be brought up on the floor of the House as soon as possible. While the measure was opposed by General Jadwin, the former chief of engineers, this objection was withdrawn when General Brown assumed the office. In expressing his views on the subject, General Brown informed the committee that he does not believe any reason exists for supposing that the research work of a hydraulic laboratory would interfere with the activities of the army engineers.

Although it was not believed necessary by those supporting the bill, an amendment was attached to prevent the proposed hydraulic laboratory from instituting any research work bearing on the activities of other government departments except at the request of the bureau concerned. This amendment was conceived by Representative W. E. Hull of Illinois and had the support of Chairman Dempsey of the committee. The limitation has been imposed because of the fear that the directors of the laboratory may start research work of their own volition which would bring about controversies with the departments in charge of the work.

The report acknowledges that for specific projects under prosecution by the War Department, field research work in hydraulics is sometimes necessary. In most cases, however, it is believed that a laboratory at the Bureau of Standards, as is proposed in the bill, will be able to take care of all hydraulic research problems submitted by public and private agencies. The Bureau of Standards already possesses a concrete flume 6 ft. wide, 7 ft. deep, and 400 ft. long, which can be made an integral part of the laboratory.

Oil Duty Now a Major Issue of Tariff Bill

Though the oil tariff proposed by Senator Thomas of Oklahoma was defeated two weeks ago by a Senate vote of 27 to 39, a reconsideration is to come. Alleged vote trading with other major items whose tariff status is unfixed, particularly lumber, sugar, and cement, gives petroleum, now on the free list, an even break for a dutiable status. The proposed rates are $1 per barrel on crude and fuel oil and 50 per cent ad valorem on refined products including distillates and derivatives such as gasoline, kerosene, naphtha, paraffin, etc.

The Senate Lobby Committee has been investigating the activities of Southwestern oil delegates who came to Washington a few weeks ago under the leadership of Wirt Franklin, president of the Independent Petroleum Association of America. Before this group started working, an oil tariff hardly had been mentioned. Now it becomes one of the major issues at this phase of the bill. The lobbying methods used are said to have been naive in appearance but very effective.

In case the petroleum tariff is not adopted, Senator Thomas intends to introduce a resolution asking a price investigation of the oil industry through the Federal Trade Commission working with a Senate committee.

Evans and Wagner Awarded Montefiore Prize

The George Montefiore Prize for the year 1929 has been awarded to R. D. Evans and C. F. Wagner, Westinghouse engineers, in conjunction with three other engineers, Algeri Marino of Rome, and H. Parodi and Pestarine of Paris. This triennial prize presented by the Foundation George Montefiore of Liege, Belgium, for the best original work contributing to scientific advancement in the technical applications of electricity, was given to Evans and Wagner for their papers on "Studies of Transmission Stability" and "Static Stability Limits and the Intermediate Condenser Station." The amount awarded was 3,000 Belgian francs.

Evans and Wagner are prominent transmission engineers of the Westinghouse company, having served in various important capacities in conducting research work in transmission line problems and power system stability. Both men are authors of many technical papers presented before the A.I.E.E.

News of Canada

Dominion Government unfavorable to St. Lawrence development at present—Large budget for B. C. Corporation—Lois River project

FURTHER progress in the settlement of differences in power matters between the Dominion Government and the provinces of Ontario and Quebec is understood to have been made at a second conference held in Ottawa on March 9. While very few facts relating to either of the conferences have been made public as yet, one thing, which comes into bolder relief with each succeeding meeting between the representatives of the various governments, is that any large, concerted effort at a deep St. Lawrence waterway is highly improbable for some years. Such a project, to be undertaken as a single, unbroken scheme similar, for example, to the new Welland ship canal, is considered to be out of the question.

It was disclosed at the two conferences that, eminently preferable from a financial and engineering viewpoint, would be an enlarged seaway brought about by a slow sectional method. It was shown by engineers who supplied data to the conference that a much cheaper method of providing both power and eventually a deeper seaway would be to proceed one step at a time, or one power development at a time, the dam necessary for this development in each case being so planned, so constructed, so located as to become also an integral part of the larger seaway to follow. By sectional power development determined as to location and size and by demand for hydro-electricity in the given area, it is agreed by the engineers for the three governments, is probably the safest and most economical procedure for providing both power and navigation needs on the upper St. Lawrence.

As to the international features of the St. Lawrence situation, there does not at present seem to be any feverish anxiety on the part of the present Dominion Government to do business with Washington on the St. Lawrence waterway matter. Any further communications are certain to await a final disposition at Washington of the present tariff legislation in Congress. A large factor in the further postponement of the St. Lawrence power-seaway project is the decision, made known many months ago by Premier Ferguson of Ontario, to get all the water power he can from the province of Quebec and leave intact whatever water power reserves there remain in Ontario.

THE 1930 BUDGET of the British Columbia Power Corporation calls for an expenditure of approximately $9,500,000. The heaviest item of expenditure will be in connection with the company's power systems. The year will see the completion of the first unit of the new Ruskin plant near Vancouver,

which will develop 47,000 hp. Work will also proceed during the year on the Bridge River development 135 miles north of Vancouver, the first unit of which will develop 54,000 hp. It is expected that during July the 2½-mile tunnel will be completed. This tunnel has a capacity of 216,000 hp. and the entire project an ultimate development of 600,000 hp. The cost of the first stage of the development, which will be completed by 1932, will be $14,000,000. The company has also awarded contracts for the installation of a 16,100-hp. unit in the Jordan River plant, 40 miles from Victoria.

DEVELOPMENT of the Powell River Company's power site on the Lois River in British Columbia is proceeding in advance of its schedule, despite adverse weather conditions. The project is capable of supplying approximately 18,000 hp., and construction will involve expenditure of about $6,000,000. A tunnel, which will carry water from the dam to the power house over a distance of 1¼ miles, is being driven from two portals, while the work will shortly be assisted by completion of a 17-mile transmission line from the company's plant at Powell River. Excavation at the site of the temporary dam is proceeding. This dam will raise the level of the Lois River and the two lower lakes and later serve to facilitate construction of a larger dam further down stream, when the second unit of the project is put under way.

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Obituary

CLARENCE A. CARR, retired rear admiral of the United States Navy, died suddenly on March 9 at his home in Pequot Colony, near New London, Conn. He was 73 years old.

Graduated from the United States Naval Academy at Annapolis, Md., in 1879, Admiral Carr was assigned to the U.S.S. "Kearsage" as assistant engineer. In 1882 he became professor of marine engineering at Stevens Institute of Technology in Hoboken, N. J., where he served until 1892. During this time he was connected with the Bureau of Steam Engineering of the Navy Department. In 1898 he was commissioned chief engineer of the U.S.S. "Marblehead."

From 1902 to 1904 he was inspector of machinery at Seattle, and for the next two years, fleet engineer of the Pacific Coast Squadron and in charge of steam engineering on the U.S.S. "Texas." He served as head of the Department of Steam Engineering at the Mare Island navy yard, San Francisco, from 1906 to 1910; inspector of machinery at Bayonne, N. J., from 1911 to 1917; engineering officer of the Philadelphia navy yard, from July, 1917, to 1919, and was retired on July 22, 1921.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual spring meeting at the Atlanta Biltmore Hotel, Atlanta, Ga., May 7-9. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting at society headquarters in New York City, April 22-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

National Power Show. Held in connection with the International Textile Exposition at Mechanics Building, Boston, Mass., April 28 to May 3. For information, write to the New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

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Personals

EMIL A. NELSON, recently connected with the Springfield Boiler Company as mechanical engineer, has accepted a position with the city water works plant at Springfield, Ill., where he will serve as combustion engineer and boiler room superintendent.

ALEX DOW and J. W. PARKER, president and chief engineer, respectively, of the Detroit Edison Company, returned last week from a month's visit in England, where they inspected the 10,000-kw., high-temperature steam turbine built for them by the British Thompson-Houston Company, Ltd. J. H. WALKER, superintendent of heating, who was a member of the party, is staying on to visit some power plants of British and European design.

JOHN P. CONNELLY has been appointed assistant superintendent of construction in New England for the York Ice Machinery Corporation. He will have his headquarters at Boston, Mass.

ARNOLD W. MILLIKEN, formerly steam test engineer at the Cannon Street station of the New Bedford (Mass.) Gas & Edison Light Company, has been appointed manager of the company's electric department.

E. R. NORRIS has been made assistant to J. S. TRITLE, vice-president in charge of manufacturing of the Westinghouse Electric & Manufacturing Company. Formerly general works manager, Mr. Norris will now be responsible for all plant facilities, manufacturing methods, cost reduction and inspection for the company.

OTTO A. BANNER, in addition to acting as a consultant for the Busch-Sulzer Brothers Diesel Engine Company as reported last week in this column, is chief engineer and manager of the coupling department of the John Waldron Corporation.

IVAR LUNDGAARD, formerly associated with the Rochester Gas & Electric Corporation, will, after an absence of nine years, assume his duties as manager of its industrial and engineering department. He will succeed E. L. WILDER, who has become affiliated with the Associated Gas & Electric Company. Mr. Lundgaard is a native of Norway and received his higher education in a Norwegian university, graduating as a mechanical engineer. He came to America in 1904 and after working in several cities joined the Rochester utility as designing engineer.

JOHN W. SHEEHEY, division manager of the Burlington Division, Green Mountain Power Corporation, has been appointed operating manager in charge of all plants, lines and power and lighting departments.

Business Notes

THE FOXBORO COMPANY, Foxboro, Mass., announces the removal of its Los Angeles office to 2307 East Eighth St., Los Angeles, Calif. This office, according to the company, has been reorganized with an entirely new staff of trained engineers, of which Dudley M. Hill is in charge.

READING CHAIN & BLOCK CORPORATION, Reading, Pa., announces that due to increased business W. C. Minier, formerly with the Shepard Crane & Hoist Company, and F. C. Lorenz, formerly with the Cleveland Electric Tramrail Company, have been added to the sales and engineering staff of its Cleveland office, Rockefeller Building, Cleveland, Ohio.

YALE & TOWNE MANUFACTURING COMPANY, Stamford, Conn., announces the opening of its Syracuse, N. Y., sales office at Room 534, Gurney Building, for the sales and service of materials handling equipment. H. R. Bungay, Jr., will be in charge of this office and will be assisted by George Sherrill.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., has appointed L. C. Bullington, formerly manager of the Detroit office, general sales supervisor of the company with his office at East Pittsburgh.

THE WELLMAN ENGINEERING COMPANY, is the new corporate name of The Wellman-Seaver-Morgan Company, Cleveland, Ohio. There is no change in management.

DELTA-STAR ELECTRIC COMPANY, Chicago, Ill., announces the opening of its new district office at Boston, Mass., located in Room 704, Statler Building. H. A. Squires will be in charge of this office and will be assisted by G. E. Buchanan.

ELECTRIC MACHINERY MANUFACTURING COMPANY, Minneapolis, Minn., announces the removal of its Detroit, Mich., office to 10-230 General Motors Building.

CHICAGO PNEUMATIC TOOL COMPANY, New York City, announces the opening of a branch office at 327 Philcade Building, Tulsa, Okla., with George J. Lynch in charge.

THE BRISTOL COMPANY, Waterbury, Conn., has recently opened a new sales and service office in Los Angeles, Calif. S. W. Case is district manager and W. H. Rogers, sales and service engineer for this office.

COMBUSTION ENGINEERING CORPORATION, New York City, announces the removal of its Hazleton, Pa., representative, the Coxe Stoker Engineering Company, to Room 1109-14, Markle Bank Building.

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With the SOCIETY SECTIONS

A.S.M.E., Metropolitan Section. Power division meeting in Room 501, Engineering Societies Building, on March 25 at 8 p.m. Subject: "Progress in the Use of High-Pressure Steam," by J. B. Crane, high-pressure specialist of the Combustion Engineering Corporation, New York City.

A.S.M.E., New Haven Section. Meeting at the Mason Laboratory on March 18 at 8 p.m. Subject: "Industrial Power," by P. W. Swain, associate editor of *Power*.

A.I.E.E., Niagara Frontier Section. Meeting at Niagara Falls Power House No. 2 on April 18. Subject: "Use of Regulators in Industry," by J. H. Ashbaugh, regulator engineer of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Midwest Bituminous Coal Conference. Held under the direction of the Engineering Schools of Purdue University, Coal Trade Association of Indiana and Illinois Coal Bureau, at Lafayette, Ind., April 9-11. Chairman, W. A. Knapp, Purdue University, Lafayette, Ind.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

Northwest Electric Light & Power Association. Engineering section; seventh annual meeting at the Hotel Morck, Aberdeen, Wash., March 26-28. Secretary, B. H. Snow, 1206 Spalding Bldg., Portland, Ore.

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Trade Catalogs

HOISTS—A unique piece of trade literature, illustrating in color the various types of American hoists and derricks, has just been published by the American Hoist & Derrick Company, St. Paul, Minn.

CONVEYORS—Stephens-Adamson Manufacturing Company, Aurora, Ill., has just issued catalog No. 30 covering conveying, elevating, screening and transmission machinery. Packed full of descriptive matter, engineering data, tables and charts, this 951-page illustrated clothbound book sells for $3.

PUMPS—Bulletin No. 30, of W. P. Whittington, Inc., 122 East Michigan St., Indianapolis, Ind., describes the construction and operation of liquid-piston, vacuum-heating pumps of various capacities.

AIR FILTERS—For engines and compressors are described and illustrated in an 8-page bulletin, No. 120, issued by the Reed Air Filter Company, Louisville, Ky.

BOILERS—Construction and installation specifications for Wickes L-O heating boilers, are given in an attractively illustrated, 12-page bulletin, No. 29A, recently published by the Wickes Boiler Company, Saginaw, Mich.

ALLOYS—Full details on the applications of "Everdur," an alloy of copper, silicon and manganese, are given in an 18-page illustrated booklet (Anaconda Publication E2) of the American Brass Company, Waterbury, Conn. Anaconda Publications E4 and E5 describe the physical properties, constants, corrosion data and welding of this alloy.

STOKERS—Underfeed stokers for heating plants are described and illustrated in Catalog S-51 of The Brownel Company, Dayton, Ohio. Operation data and views of typical installations add to the interest of this 12-page booklet.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20 @ $2.30
Kanawha	Columbus	1.35 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.25
Smokeless	Chicago	1.75 @ 2.25
S. E. Kentucky	Chicago	1.40 @ 1.60
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.35 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.70 @ 3.00
Barley	New York	1.40 @ 1.50

FUEL OIL

New York—Mar. 13, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Mar. 7, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1,595 per bbl., or 42 gal.; 26@28 deg., $1.645 per bbl.; 28@30 deg., $1.695 per bbl.; 30@32 deg., $1.745 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—Mar. 11, f.o.b. local refinery, 30@34 deg., fuel oil, 4.5@4.75c. per gal.; 36@40 deg., 4.75c.

Philadelphia—Mar. 4, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Mar. 4, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Mar. 4, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.05@$1.10 per bbl.; 30@32 deg., $1.30@$1.35 per bbl.

Boston—Mar. 10, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.2c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Mar. 8, f.o.b. local refinery 26@30 deg., $1.30 per bbl. or 42 gallons

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Fresno—San Joanquin Light & Power Co., Power Co. Bldg., subsidiary of Great Western Power Co., 437 Sutter St., San Francisco, awarded contract for the construction of a steam power plant here, to McClellan & Junkerfeld Inc., 120 Broadway, New York, N. Y. Estimated cost $3,500,000.

Calif., Laguna Beach—City is having plans prepared for the construction of a sewage system including disposal plant, two pumping plants, etc. A. J. Stead, is city engineer. J. B. Lippincott, Petroleum Securities Bldg., Los Angeles, is consulting engineer.

Conn., West Haven—Hygenic Ice Corp., 881 Hartford R.R. Co., will soon award contract for the installation of a central heating plant Estimated cost to exceed $40,000 R. L. Pearson, Ch. Engr.

Conn., New Haven—New York, New Haven & State St., awarded contract for the construction of an ice manufacturing plant to C. W. Murdock Co., 505 Grand St. Estimated cost to exceed $40,000.

Ill., Stickney—Sanitary District of Chicago, R. A. Woodhull, Chn. of Finance Committee, 910 South Michigan Ave., Chicago, awarded contract for the construction of railway and plant structures including locomotive terminal, repair building, transformer house, sludge control building, etc. for West Side Sewage Treatment Works, Pershing Rd. and South 52nd Ave., here to Hanson Bros. Co., 127 North Dearborn St., Chicago. $595,966.

Ind., Indianapolis—Insane Hospital, awarded contract for the construction of a power house to Callon Bros., 24 South Alabama St. Estimated cost $65,000. Contract let for mechanical installations.

Ky., Bowling Green — Kentucky Tennessee Light & Power Co., subsidiary of Associated Gas & Electric Co., 61 Broadway, New York, N. Y., plans the construction of first unit of power plant at Barren River here. Estimated cost $1,500,000.

Mass., Brighton (sta. Boston)—Harvard University, Cambridge, is having plans prepared for the construction of a 1 story 75 x 100 ft. power house at Harvard Medical School, here. Densmore, LeClear & Robbins, Park Sq. Bldg., Boston, are architects and engineers.

Mich., Alma — **Grand Lodge F. & A. M.** awarded contract for the construction of a 3 story, 195 x 355 ft. home including 45 x 120 ft. boiler house and laundry, etc. on Wright Ave. to Henry C. Weber Construction Co., Bay City. Estimated cost $650,000.

Minnesota—Northern States Power Co., R. F. Pack, V. Pres. and Gen. Mgr., 15 South 5th St., announces a construction program for 1930 totaling $12,365,559. Plans include laying an additional 13,000 v. cable from Aldrich substation to downtown district; constructing a new 110,000 v. sub-station in south side of city near Wilson sub-station; new 13,000 v. substation on north side of city including connection lines to Riverside and Penn sub-stations; improvements to Aldrich sub-station; 66,000 v. transmission line between Chaska and Young America including necessary switching equipment at Young America; rebuilding and enlarging sub-station at Wayzata; installation of a 3,000 kw. generator at Fargo; 2,500 kw. generating unit at Minot steam plant; 16,500 v. line between Delano and Montrose.

Mo., California—City, F. H. Hert, Clk., plans an election Apr. 1, to vote $45,000 bonds for an electric light plant, equipment and distribution system, Ervin Mueller, is engineer.

Mo., Campbell—City plans the construction of a municipal power plant and distribution system. Estimated cost $60,000. Russell & Axon, 6200 Easton St., St. Louis, are engineers.

Mo., Sikeston—City plans an election Apr. 1, to vote $150,000 bonds for the construction of an electric light and power plant and distribution system. Estimated cost $150,000.

N. J., Asbury Park—Monmouth Title & Mortgage & Guaranty Co. and Lincoln Mortgage & Title Co., 416 Main St., awarded contract for the construction of a 15 story office building at South Main St. and Wesley Lake Dr. to Klausner, Inc., Professional Bldg. Estimated cost $750,000. Steam heating, and ventilating systems, boilers, elevators, etc., will be installed.

N. J., Jersey City—Harris & Sohn, 101 Park Ave., New York, N. Y., Archts., will receive bids about Apr. 1, for the construction of a 10 story medical office building including steam heating, and ventilation systems, boilers, elevators, etc. at Tonnelle and Sip Aves, here for Journal Sq. Medical Building Inc. W. J. Quinn, Pres., c/o Dept. of Revenue and Finance, City Hall, Jersey City. Estimated cost $1,000,000.

N. J., Newark — City Center Corp., c/o Flanagan & Kennedy, 578 Madison Ave., New York, N. Y., Archts., plans the construction of an office building, hotel, etc. including steam heating and ventilation systems, boilers, pumps, elevators, etc. at Farmers Market Plaza. Estimated cost $15,000,000.

N. J., Toms River—Industrial Institute, c/o J. Rosenbloom, 26 Court St., Brooklyn, N. Y., awarded contract for the construction of an industrial school including refrigeration plant, steam power plant, experimental laboratory, machine and repair shops, storage warehouse, etc. here, to Interstate Building & Development Co., 250 West 57th St. New York, N. Y. Estimated total cost $2,000,000.

N. Y., New York—**Miramar Pool Corp., 408** West 207th St., plans the construction of an ice skating rink, indoor swimming pool, etc., at 206th St. and 408 West 207th St. Estimated cost $350,000.

Pa., Ford City—City, plans the construction of an electric light plant in Armstrong Co. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., are engineers.

Pa., Mosgrove — West Pennsylvania Power Co., West Pennsylvania Bldg., Pittsburgh, plans the construction of a power house 35,000 hp. at Lock and dam No. 8 on Allegheny River here. Sanderson & Porter, 52 William St., New York, N. Y., are mechanical and structural engineers.

Tex., San Antonio—Scobey Fireproof Storage Co., F. E. Scobey, Pres., 311 North Medina St., will receive bids about Apr. 15 for the construction of a 4 story, 100 x 166 ft. cold storage warehouse at 300 Blk. North Medina St. Estimated cost $225,000. Engineering Service Corp., 1806 Post Dispatch Bldg., Houston, is architect and engineer.

Wash., Seattle—Bd. of Public Works, G. W. Roberge, Secy., awarded contract for furnishing generators and transformers to Westinghouse Electric & Mfg. Co., Lloyd Bldg., Maloney Electric Co., Smith Tower; waterwheels, to S. Morgan Smith Co., in connection with Diablo hydro-electric power development on Skagit River. Estimated total cost $1,500,000. Contract for two butterfly valves not yet awarded. Bids for the construction of the power house will be received soon.

B. C., Phillips Canyon—East Kootenay Power Co., Fernie, plans development of Elk River near Elko to create 20,000 hp.

Ontario—Hydro Electric Power Commission of Ontario, 190 University Ave., Toronto, plans to expend $6,600,000 during 1930 for hydro-electric developments at various points; Chats Falls development $2,000,000; Carillon Falls development $500,000; additions and improvements to 220,000 v. sub-station $1,250,000; rural power distribution lines, $750,000; Alexandria development $1,000,000; Mississouga development $1,000,000; transformer stations in Ottawa River district. $100,000. F. A. Gaby, 190 University Ave., Toronto, is engineer.

B. C., Victoria—Canadian Pacific Ry. Co., Windsor Station, Montreal, Que., plans the construction of a laundry and power house here in connection with proposed $50,000,000 program.

Equipment Wanted

Boilers, Super Heater, etc.—Columbia, Mo.—City, J. S. Bicknell, Clk., will receive bids until Mar. 21, for two 600 hp. boilers, super heater, chain grate forced draft plant, etc. for proposed electric light plant. Estimated cost $75,000.

Generator Units—St. George (sta. Staten Island)—Supt. of Lighthouses, will receive bids until Mar. 27 for 7½ kw. internal combustion engine driven marine generator units using kerosene for fuel.

Power Plant Equipment—Wilson, N. C.—Mayor and Bd. of Comrs., will receive bids until Mar. 25, for power plant equipment including 5,000 kw. turbo-generator unit with direct connected exciter, generator air cooler and appurtenances; generation switchboard panel; exciter switchboard panel; feeder panel; surface condenser complete with pumps; boilers, stokers, feed water heater, superheaters, etc.

Pumping Equipment—Big Spring, Tex.—City plans to purchase pumping equipment, etc. for proposed waterworks improvements. Estimated cost $115,000.

Pumps—Pennsylvania and Ohio—Sun Oil Co., S. B. Eckert, V. Pres., Finance Bldg., Philadelphia, centrifugal pumps for proposed 550 mi. gasoline pipe line from Marcus Hook, Pa. to Cleveland, O.

Pumps, etc.—Oakdale, Pa.—City will receive bids until Apr. 1 for pumps, etc. for proposed waterworks improvements. Estimated cost $24,000.

Pumps, etc.—Shaler, Pa.—Shaler Township, M. C. Smith, Clk., Braun School, Glenshaw, will receive bids until Mar. 26 for 300 g.p.m. centrifugal pumps, etc., for proposed waterworks system.

Industrial Projects

Calif., Los Angeles—Gillespie Furniture Co., awarded contract for the construction of a 1 story, 140 x 450 ft. factory at East Pico and Alosta Sts. to The Austin Co. of California, 777 East Washington St. Estimated cost $150,000.

Idaho, Priest River—Pacific States Pulp & Paper Co., 71 Columbia St., Seattle, A. T. Peterson, V. Pres., Priest River, is having preliminary plans prepared for the construction of a pulp mill, 100 ton of sulphate per day. Estimated cost $1,500,000.

N. H., Laconia—Scott & Williams Inc., manufacturers of knitting machinery, awarded contract for the design and construction of a 4 story, 63 x 270 ft. factory to Lockwood Greene Engrs. Inc., 24 Federal St., Boston, Mass.

N. J., Camden—B. F. Sturtevant Co., Thorne and Copewood Sts., manufacturers of blowers, awarded contract for the construction of a 1 and 2 story, 100 x 260 and 40 x 100 ft. factory at Cresmont St. here, to Barclay White Co., 22 North 36th St., Philadelphia, Pa.

N. J., Jersey City—R. Ludwig, 316 West 56th St., New York, N. Y., Archt., is receiving bids for the construction of a 5 story, 50 x 100 ft. factory and storage building for the manufacture of chemicals here, for Gergy Co. Inc., 58 Mill Rd., Jersey City. Estimated cost $75,000.

N. J., Newark — P. B. West, 24 Commerce St., Archt., will receive bids about Mar. 15, for the construction of a 2 story factory at Maple Pl. for General Alloy Co., 188 New Jersey Railroad Ave. Estimated cost $40,000.

Pa., Butler—Castle Rubber Co., N. D. Brown, Secy. and Treas., Etna St., manufacturers of mechanical rubber products, awarded contract for a 1 story, 72 x 325 ft. factory and 36 x 40 ft. power house on East Butler St., to L. Etzel, Great Belt.

Pa., Farmers Valley (mail Smithport)—McKean County Refining Co., W. H. Rockman, awarded contract for the construction of a group of buildings including 2 story, 50 x 120 ft. barrel house; 1 story, 65 x 72 ft. wax house; new boiler house, 400 hp., coaling building, 300 ton; burner building, 16 burners; 2 story, 50 x 200 ft. shop building and 24 x 38 ft. office to L. O. Boquin Co., 11 East First St., Oil City.

Pa., Norristown — The Wildman Mfg. Co., manufacturers of knitting machinery, awarded contract for the construction of a 1 story, 100 x 200 ft. factory to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $200,000.

Pa., Pittsburgh—W. E. Moore Co., 32nd St. (Mechanical engineer and electric furnace builders) is receiving preliminary bids for a 3 story, 305 x 455 x 178 ft. plant including loading platform, 25 x 20 ft. crane; electric elevators, etc. at 32nd St. and Putney Way. Estimated cost $100,000. Private plans.

Tenn., Memphis—Southern Cotton Oil Co., K. C. Junction, awarded contract for mill additions including 4 story, 87 x 100 ft. refinery, 22 x 55 ft. laboratory, 40 x 100 ft. acidating plant and fifty-five oil tanks, 60,000 to 100,000 lb. capacity at Southern R.R. and Bellevue Blvd. to S. and W. Construction Co., Shrine Bldg. Estimated cost $250,000.

Tex., Sweetwater — International Harvester Co., c/o W. D. Price Supt. of Const. Harvester Bldg., Chicago, Ill., awarded contract for the construction of a 1 and 2 story 100 x 183 and 100 x 300 ft. factory to Kucharo Construction Co., 1342 South Flores St., San Antonio. Estimated cost $160,000.

Virginia—Southern Mineral Products Co., subsidiary of Vanadium Corp. of America, 120 Broadway, New York, N. Y., awarded contract for first unit of mining, milling and chemical plant in Amherst and Nelson counties here to Stone & Webster Engineering Corp., 120 Broadway, New York, N. Y. Estimated cost $1,500,000.

Wash., Seattle—American Can Co., Elliott and Vine Sts., awarded contract for the construction of a 3 story, 140 x 550 ft. factory at Railroad Ave. and Vine St. to A. W. Quist & Co., Hoge Bldg. Machinery and equipment to cost $250,000 will be installed. Total estimated cost $1,250,000.

Ont., Hamilton — B. H. and F. Prack, 36 James St. S., Archts., are receiving bids for the construction of a 2 story, 65 x 142 ft., factory for Hoover Mfg. Co., Ltd., Gage St. N. (manufacturers of vacuum cleaners). Estimated cost $100,000.

Ont., Ottawa—Armstrong-Siddeley Co., England, is having plans prepared for the construction of a factory for the manufacture of airplane engines, air and sea planes, etc. at Brittania here. Estimated cost $1,000,000. Ottawa Car Mfg. Co., Ottawa, Agent.